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Schlumberger Technologies

Instruments Division

7071 COMPUTING MULTIMETER

OPERATING MANUAL: PART 1

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N O T I C E

CHANGES IN THE VALUES OF THE NATIONAL REFERENCE STANDARDS OF EMF AND RESISTANCE

The values of the National Reference Standards for emf and resistance maintained by NPL were decreased by 8.06 ppm and 1.61 ppm respectively on 1 January 1990.(Reference NPL Publication - Changes in the Values of the United Kingdom Reference Standards of Electromotive Force and Resistance).

The calibration of this instrument reflects these changes.

When comparing values given by this calibration with measurements made before 1 January 1990 these changes should be taken into account.

7071
Computing Multimeter

OPERATING MANUAL
Part 1

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Schlumberger pursue a policy of continuous development and product improvement.
The specification in this document may therefore be changed without notice.

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SAFETY

The instrument has been designed and tested in accordance with the recommendations of IEC 348 Class 1. It is primarily intended for indoor use, and for such use it is supplied in a safe condition. However, no degradation of its safety will be caused if it is occasionally subjected to temperatures below normal room temperature (see Specification).

This manual contains information and warnings which the user should follow to ensure his own safety and the continued safe operation of the instrument. 7071 has been engineered with ease of use as one of the primary considerations. Attention has also been given to making the instrument immune to most inadvertent overloads. It should be appreciated, however, that even the most sophisticated measuring instrument can be dangerous when connected to high voltages, unless elementary safety precautions are observed.

The voltage limits of 1kV on AC and DC mean that no damage will be caused to the instrument at this level of input. Other than the displayed reading, however, no indication is given to the user that a voltage of such a magnitude is present at the input terminals. Care should therefore be exercised whenever the dvm input leads are being connected to/removed from live circuits, especially where high voltages are known to exist, or high transients could occur.

Similarly, when using the instrument on mains operated equipment capable of delivering high voltage outputs, it is strongly recommended that the equipment under test is NOT switched off with the dvm still connected. For example, consider 7071 connected across the secondary winding of a large mains transformer. The instruments very high input resistance is such that, in the event of the mains supply being interrupted, the resultant back emf induced in the undamped secondary could be in the order of 100kV. This is obviously hazardous to the user and would certainly harm the voltmeter.

When measuring high voltages, always ensure that the 7071 Hi and Lo inputs are connected correctly, i.e. Hi to the largest potential with respect to earth, Lo to the lowest. Once the measurement has been taken, disconnect 7071 from the high voltage equipment before switching the equipment off. User safety can be improved in these circumstances by the inclusion of a switch between the 7071 and the high voltage equipment; the switch could then be turned on, and off, whilst the equipment remained powered.

Whenever it is likely that the safety of the instrument has been impaired, e.g. if it shows visible signs of damage, if it fails to perform correctly, or if the specifications have been exceeded in any way, it should be made inoperative and referred to a suitable repair organisation.

Any adjustment, maintenance or repair of this instrument should be carried out only by a skilled person who is aware of the hazards associated with mains operated equipment. Such adjustment, maintenance or repair should be carried out in accordance with the procedures, and observing the precautions, detailed in the Maintenance Manual.

INTRODUCTION

The 7071 operating manual is arranged in two separate parts, covering local and systems (remote) use. Each part contains all the information necessary for operating the instrument in that particular role.

Included in Part 1 is the specification applicable to the functions described, the tables showing the expected instrument performance relative to time since calibration. A further section of Part 1 is devoted to the unit's processing capabilities and front panel operations. Part 2 describes the use of the instrument in a systems environment.

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Chapter 1
General Information

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1 Introduction

The 7071 voltmeter is a high quality instrument designed for calibration, laboratory and systems applications. It combines superb measurement performance with data storage facilities and processing power. The unit has no internal options having all facilities as standard.

2 Facilities

The instrument provides the following facilities:

- DC voltage and resistance measurements to a scale length of 14 000 000 and true rms volts ac, or volts ac + dc, to a scale length of 1 400 000.
- The ability to ratio any of the above inputs to a dc voltage or to a constant.
- Automatic storage of results (History file).
- Processing of measurements to provide additional results.
- Remote control using either RS232C or IEEE-488 (GP-IB) interfaces.
- Calibration, via either of the two interfaces, without the need to remove covers.
- Interface for Minate analogue scanner, providing a multi-channel measurement capability.

3 Measurement Capability

DC voltage measurements can be made using scale lengths of 3½, 4½, 5½, 6½, and 7½; the 3½ scale is available only by remote control. Each scale length provides a different integration time and can be used over all ranges, i.e. 0.1 to 1000V.

Two types of ac voltage measurement are possible; a true rms value of the ac component only of an input or the rms of the total signal (ac + dc). Scale lengths of 3½, 4½, 5½, and 6½ and ranges of 0.1 to 1000V are available for both types of measurement.

Ranges of 0.1kΩ to 1000MΩ are provided for resistance measurement; the 0.1,1,10,100 and 1000kΩ ranges use a 4 terminal technique whereas the 10 to 1000MΩ ranges use a special ratio method. The 7071 also offers a 'True ohms' facility, i.e. the unit measures the resistance with the current source off and then with it on. Subtracting the former measurement from the latter removes any errors caused by thermal emfs or external currents. The 7071 'True ohms' facility can deal with emfs of up to 10V.

All measurements taken by the 7071 are averaged readings over the selected integration time.

4 Ratio

Eight types of ratio measurement are possible using either a reference input or a constant. The latter may be a measurement result accessed from the voltmeter memory or a number entered from the front panel controls. The ratios can be presented in linear or logarithmic (dB) form.

5 History File

The voltmeter has a separate memory, the history file, for storing readings. These may be straightforward measurements or processed results.

The value displayed on the voltmeter, which is subsequently stored, is not necessarily displayed or printed in the identical format on recall. Up to 1500 unformatted readings (numeric value only) can be stored or 500 fully formatted readings.

The least significant digits of unformatted (compressed format) readings may, in some instances, be invalid. Unformatted readings should therefore be interpreted in the light of the scale length and range selected. Formatted (expanded format) readings have the invalid digits set for zero.

6 Processing

The unit provides the following programs:-

Ratio
Digital Filter
Scale
Statistics
Limits and max/min

The programs may be used together or individually and are listed in their chaining order, i.e. the input data to one program may be the result of the previous program.

Access to the programs can be made either from the front panel or over the interfaces.

For further details on processing, refer to Chapter 4.

7 Interfaces

Two interfaces, the RS232C V24 and the IEEE 488/1978, are fitted as standard.

7.1 RS232 Interface

Access to this interface is via a 25-way Cannon socket on the rear of the instrument. Baud rates from 110 to 9600 are available, which are selected from three internal switches, the normal factory setting being 300 baud.

7.2 IEEE 488 Interface (GP-IB)

The unit fully implements the requirements of the IEEE 488/1978 standard, access to the interface being provided via a connector on the rear panel of the instrument. The instrument address is set up via the GP-IB Selector switches also mounted on the rear panel.

7.3 Interface Language

A common language, which is based on English, is used over both interfaces.

Comprehensive error reporting is available giving the exact position in a command where the mistake lies. A HELP command is available, if required.

For further details, refer to Part 2 of the Operating Manual.

8 Unit Calibration

Calibration is enabled via a front panel key operated switch. This allows the unit to be calibrated without removal of the covers or disturbance of the analogue circuitry.

Unit calibration is based on the equation:-

$$y = mx + c$$

where y = calibrated reading
x = uncalibrated reading
m = range/mode multiplier
c = zero offset

Every range/mode combination has its own set of constants (m and c), which are stored in a non-volatile memory with a predicted life of ten years.

Calibration can only be carried out over the IEEE or RS232C Interfaces.

9 Multi-Channel Capability

A Minate (7010) interface is also fitted to the unit. This interface is capable of driving 127 channels and provides programmable pull-in and drop-out delays, if required.

The connector has the pin/signal assignment shown in Table 1.1

Table 1.1 *Multi-Channel Connector Pin/Signal Assignment*

Pin No.	Signal
1	1 (Device control)
2	2 (Device control)
3	4 (Device control)
4	8 (Device control)
5	10 (Device control)
6	20 (Device control)
7	40 (Device control)
8	80 (Device control)
9	Contact closure remote trigger (connect to 0V)
10	Out of limit high (Logic 1 = True)
11	Out of limit low (Logic 1 = True)
12	0 Volts
13	+5 Volts (100mA max. load)
14-23	Not Used
24	TTL compatible measurement complete signal (Logic 1 = True)
25	1 kV probe enable (connect to 0V)

Figure 1.1 shows the relative positions of the pins.

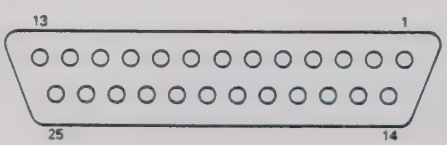


Fig 1.1 *Multi-Channel Connector*

10 Accessories

The items listed below are supplied with 7071:

Input lead
Power lead
Crocodile clips (2)
Rack ears (2) and fixing screws
Operating manual
5-way DIN plug (for connection to the rear panel reference/ratio socket)
Spare fuses: 2×200mA slo-blo and 2×400mA slo-blo
Calibration key
25-way socket kit

The following optional accessories are available for use with 7071:

3 Terminal Input Lead	3193
5 Terminal Input Lead	3183
Kelvin Clip Lead	70758E
Telescopic Rack Sliders	70759A
Low Thermal Lead	70758D
High Voltage Probe	70757A
Maintenance Manual 7071 & 7081	70810014

10.1 2 Terminal Input Lead

This input lead, supplied with 7071, may be used for all standard measurements. The RED lead should be connected to the largest potential with respect to earth. The BLACK lead provides the return path (see Figure 1.2). The cores are enclosed in a braided screen which is connected to Guard. At the free-end of the cable, this screen is connected to the black lead thus effectively preserving the guard right up to the signal source. This prevents the measurement being affected in any way by common mode current flowing in the screen and via leakage to earth. The input may be floated above mains earth by up to 350V; the use of higher common mode voltages is not recommended purely to ensure safety for equipment and the user. The guard is not made available as a separate termination.

The two Ω source leads are connected within the cable to the Hi and Lo leads and are not available as separate terminations.

The input lead can be connected to either the front or rear panel input socket. Before initiating measurements, ensure that the front panel Input Select switch is in the correct position. Refer to Chapter 3 for the switch positions.

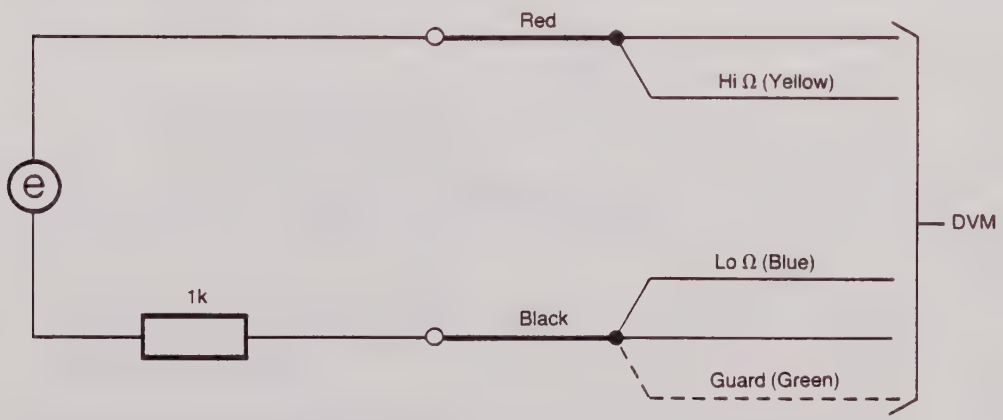


Fig 1.2 *2 Terminal Input Lead*

10.2 Reference/Ratio Plug

Three lines from this 5-way plug are used: Ratio Hi, Ratio Lo and 0V. The Ratio Hi and Lo lines must not have more than ±14V, with respect to 0V, connected to them, the voltage measured being the difference between these two lines.

Ratio Hi should be connected to the higher reference potential, Ratio Lo to the lower reference potential. Ratio Lo can be connected to 0V only if Ratio Lo is connected to the main input Lo.

Fig 1.3 *Rear Panel Reference Socket*

10.3 3 Terminal Input Lead

The 3 Terminal Input Lead, Part No. 3193, can be used to eliminate sources of interference in the circuit under measurement.

Within the instrument the cable screen is connected to the guard 'box' (a screening compartment which encloses the input circuits) and at the free end the screen is connected directly to the source of interference thus isolating common mode current from the input leads. (See Figure 1.4).

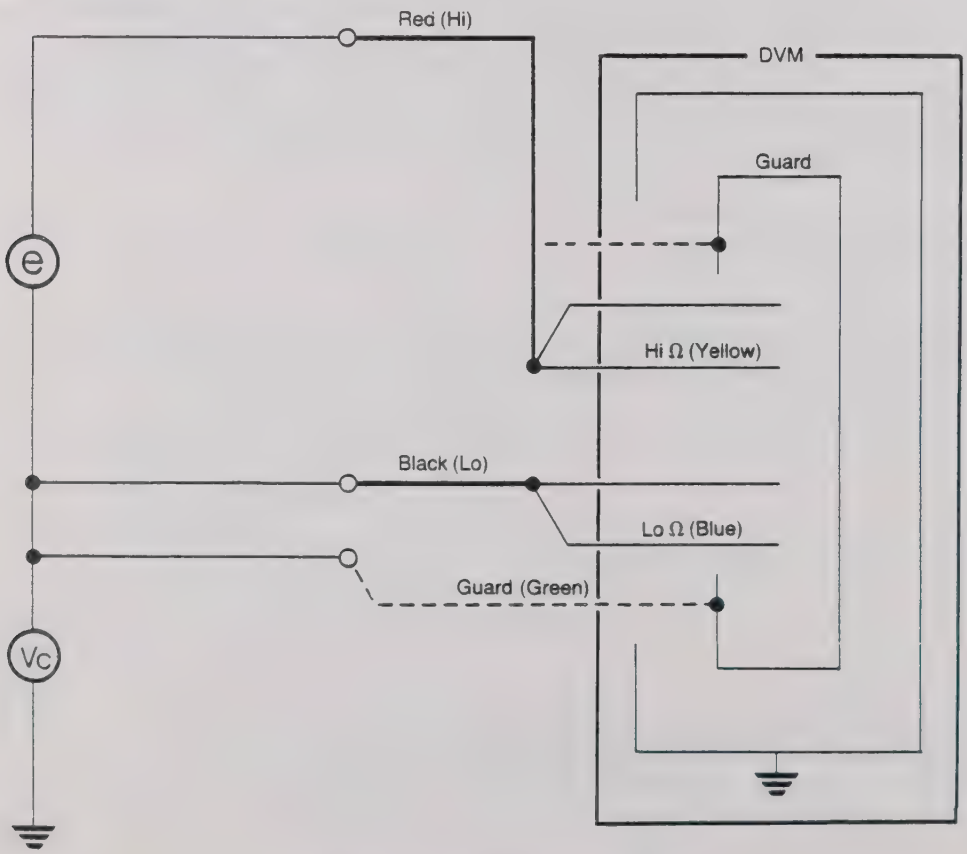


Fig 1.4 *3 Terminal Input Lead*

Using this arrangement, even if the interference was the permitted maximum, it is most unlikely that there would be any discernable error, even at the most sensitive range.

If 'Guard' can not be connected directly to an interference source, it should be connected to the Lo line, i.e. not left unconnected.

10.4 5 Terminal Input Lead

The 5 Terminal Input Lead, Part No. 3183, can be used for resistance measurements and has the four cores and guard screen terminated separately as shown in Figure 1.5.

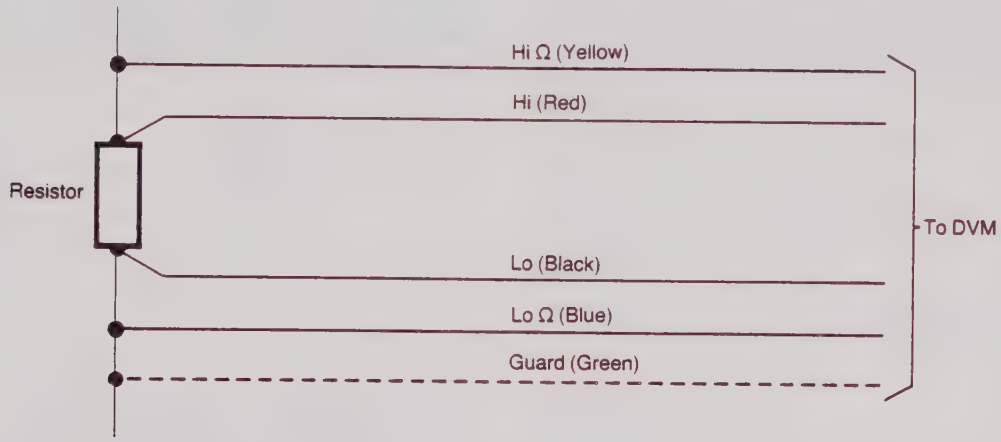


Fig 1.5 *5 Terminal Input Lead*

When measuring low values of resistance, the voltage dropped along the leads can sometimes introduce errors. This effect may be eliminated by employing the 4 wire technique in which two wires supply the current to the resistor and two others sense the potential developed across it. The guard screen can be used to reduce any errors due to common mode interference.

10.5 High Voltage Probe (70757A)

The High Voltage (H.V.) probe effectively increases the dc voltage range of the voltmeter, to a maximum of 20kV.

Safety Precautions: When using the H.V. probe, the following safety precautions should be observed.

Do not use the instrument in the Autorange mode as damage might occur.

The 50 way cannon plug supplied with the probe must be inserted into the minate interface at the rear of the instrument. This secures the instrument for this mode of operation. The display reads in kV.

Know the equipment under test; locate all high voltage points before commencing work.

Do not work alone.

Do not depend on the insulation of high voltage cables for protection.

Remember that high voltages may appear at unexpected points in defective equipment. Note that even though equipment may be switched off, bleeder resistors may be open circuited and capacitors charged to high voltages.

High voltages can discharge from point to point or point to air (corona). Keep hand closed on the handle of the probe and away from high voltage points.

Keep hands and shoes and test area absolutely dry.

Ensure that the surface of the probe is clean and moisture free.

BEFORE MAKING ANY MEASUREMENT, ENSURE THAT THE GROUND LEAD OF THE PROBE IS CONNECTED TO THE LOW POTENTIAL OR GROUND SIDE OF THE HIGH VOLTAGE SUPPLY BEING MEASURED.

11 SPECIFICATION

ROOT-YEAR RELATIONSHIP

Realistic specifications should not be based on speculation. They require a real knowledge of components, their behaviour under stress, and their drift with time.

Long term assessment of precision components has enabled Schlumberger to specify performance from 90 days to 9 years using a simple square-root-year relationship for calibration drift with time. Tests conducted over several years using precision resistors and zeners from many leading manufacturers indicate that drift reduces with time and the change is proportional to the square root of time. Using pre-aged, hermetically encapsulated components, the drift is reduced to extremely low levels and can be predicted accurately for short or long periods. Accuracy specified for one year can be used with a multiplier to provide all additional information, as shown below:

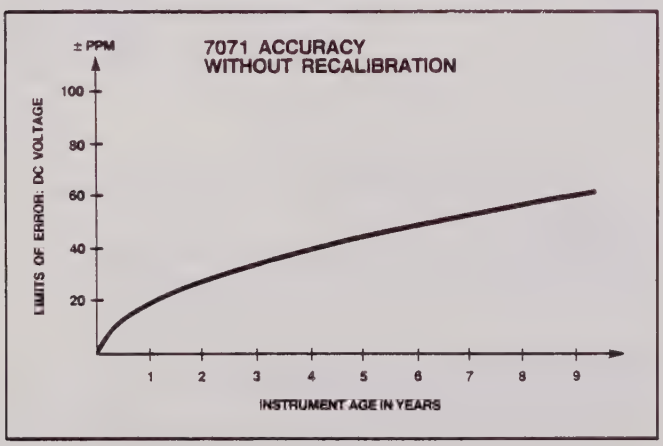
Required Spec Time	One Year Multiplier
3 months	0.5
6 months	0.7
1 year	1.0
2 years	1.4
4 years	2.0
9 years	3.0

CALIBRATED FOR LIFE

Beyond nine years the drift becomes insignificant such that three times the one year figure will predict the performance of the 7071 for the life of the voltmeter –however long that may be. Traceabiliy to International Standards can be maintained for long periods.

The square-root-year relationship applies to the 7071. The voltmeter will retain its predicted long term specification, even if subjected to rigorous working conditions. However, the best stabilty, and minimum long term drift, will be obtained by maintaining the voltmeter in a reasonable environment. The user should consider leaving the voltmeter switched on and avoid extreme environmental conditions. In these circumstances the long term performance can be expected to be even better than that which is predicted.

Calibration for life, introduced for the first time by Schlumberger, gives important savings in time and money, thus making a significant reduction in cost of ownership.



ACCURACY

The following apply to the Accuracy sections:

Limits of Error: apply after 24 hours warm-up* with ac inputs >2% of range and dc resistance with null in use.

Temperature Coefficient: expressed as ±ppm rdg/°C and valid from 10°C to 30°C.

Calibration temperature T_e is the temperature of the calibration room. Calibration occurs at 20°C (23°C for the USA) and is directly traceable to International Standards via the National Physical Laboratory or the National Bureau of Standards. Recalibration is valid at T_e from 18°C to 25°C.

Factory traceability to NPL is 1µV for standard cells, 1.5ppm for 10Vdc reference, 5ppm for resistors and 60ppm for AC/DC transfer.

Temperature coefficient need be applied only outside the temperature span quoted with T_e.

*Instruments are usable within minutes after switch-on but for ultimate precision a long warm-up in a stable thermal environment is recommended.

If an instrument has been stored at below 5°C for long, follow the special warm-up procedure given in Chapter 2, Section 3.

RATIO

Differential measurement of Hi_{ref} and Lo_{ref} with respect to input Lo on a fixed 10V dc range to establish V_{ref}.

V_{ref} maximum permitted input:	±14Vdc
V_{ref} error:	±2×error on 10V range
Ratio error:	±[V_m error + V_{ref} error]

DC VOLTAGE

Stability
24hrs, $T_e \pm 1°C$, 7½ digits, ± [ppm rdg + ppm fs]

Range	Sensitivity	Full Scale	Guaranteed	Transfer
0.1V	10nV	0.140 000 00	2.0 + 1.0	0 + 1.0
1V	100nV	1.400 000 0		
10V	1µV	14.000 000		
100V	10µV	140.000 00		
1000V	100µV	1000.000 0		

Limits of error
Predicted maximum for life: 60ppm rdg + 1ppm fs
7½ digits, $T_e \pm 5°C$, ± [ppm rdg + ppm fs]

Range	90 Day	1 Year	2nd Year*	Temp. Coeff
0.1V	10 + 1	20 + 1	10 + 1	2.0
1V				
10V				
100V				
1000V				

Scale length, integration time, tracking speed

Digits	Integration	Speed	Add Error
7½	3.2s	1/3.2s	– –
6½	0.4s	2.5/s	±1 digit
5½	0.1s	10/s	±1 digit
4½	6.25ms	85/s	±1 digit
3½	1.56ms	100/s	±1 digit

Input Resistance: 0.1, 1, 10V range:	>10GΩ
100, 1000V range:	10MΩ
Input Current, at T_e °C:	<20pA
Range of Null	±10% of range
Sample settling time:	13ms × (digits selected)

Overload protection

Autorange:	1kV pk
Commanded range: 0.1, 1, 10V:	350V pk
100, 1000V:	1kV pk

* After first year recalibration

RESISTANCE

Stability
24hrs, $T_e \pm 1°C$, 7½ digits, ± [ppm rdg + ppm fs]

Range	Sensitivity	Full Scale	Guaranteed	Transfer
0.1kΩ	10µΩ	0.140 000 00	3 + 1	0 + 1
1kΩ	100µΩ	1.400 000 0	2 + 1	0 + 1
10kΩ	1mΩ	14.000 000	2 + 1	0 + 1
100kΩ	10mΩ	140.000 00	3 + 1	0 + 1
1000kΩ	100mΩ	1400.000 0	4 + 1	0 + 1
10MΩ	1Ω	14.000 000	10 + 1	0 + 1
1000MΩ	10ppm rdg	>1400.00	1ppm/MΩ	– –

Limits of error
Predicted maximum for life: 3 × 1 Year Limits
7½ digits, $T_e \pm 5°C$, ± [ppm rdg + ppm fs]

Range	90 Day	1 Year	2nd Year*	Temp. Coeff
0.1kΩ	12 + 1	20 + 1	12 + 1	2
1kΩ	11 + 1	20 + 1	11 + 1	2
10kΩ	11 + 1	20 + 1	11 + 1	2
100kΩ	12 + 1	20 + 1	12 + 1	2
1000kΩ	13 + 1	20 + 1	13 + 1	2
10MΩ	35 + 1	60 + 1	35 + 1	5
1000MΩ	8ppm/MΩ	10ppm/MΩ	10ppm/MΩ	1ppm/MΩ

Scale length, integration time, tracking speed

Digits	Integration	Speed	Add Error
7½	3.2s	1/3.2s	– –
6½	0.4s	2.5/s	±1 digit
5½	0.1s	10/s	±1 digit
4½	6.25ms	85/s	±1 digit
3½	1.56ms	100/s	±1 digit

Measurement configuration:	4-wire, 0.1kΩ to 1000kΩ ranges		
	2-wire, 10MΩ and 1000MΩ range		
Current source, fully floating:	0.1, 1,	10kΩ	1mA
	100kΩ,	1000kΩ	10µA
	10MΩ,	1000MΩ	1µA max
Overload protection:	350V pk		
Open circuit voltage:	17V dc		
Range of Null:	±10% of range		
Maximum total lead resistance:	1kΩ		
Sample settling time:	13ms × (digits selected)		
	Add 10ms/MΩ		

Stability
The ability to remain within predefined error limits for a short time. The reading at the beginning of the time period is the datum for the limits.

Traceability
The ability to relate individual measurements to International Standards through an unbroken chain of comparisons.

Transfer Accuracy
Transfer accuracy is the short-term limit of error for measurements of similar value.

AC VOLTAGE True rms of ac or ac+dc

Stability
24 hrs, 90 Day, $T_e \pm 1°C$, ± [% reading + % full scale]

Range	Sensitivity	Full Scale	10 to 40Hz	40Hz to 10kHz	10k to 100kHz	100k to 1MHz
0.1V	1µV	0.140 000	0.05 + 0.006	0.005 + 0.005	0.02 + 0.03	1 + 1
1V	1µV	1.400 000	0.05 + 0.006	0.005 + 0.005	0.02 + 0.03	1 + 1
10V	10µV	14.000 00	0.05 + 0.006	0.015 + 0.005	0.05 + 0.03	1 + 1
100V	100µV	140.000 0	0.06 + 0.006	0.02 + 0.005	0.2 + 0.03	--
1000V	1mV	1000.000	0.08 + 0.01	0.035 + 0.007	--	--

Limits of error
1 Year, 2 Years, $T_e \pm 5°C$, ± [% reading + % full scale]

Range	Full Scale	10 to 40Hz	40Hz to 10kHz	10k to 100kHz	100k to 1MHz
0.1V	0.140 000	0.06 + 0.006	0.02 + 0.005	0.04 + 0.04	1 + 1
1V	1.400 000	0.06 + 0.006	0.02 + 0.005	0.04 + 0.04	1 + 1
10V	14.000 00	0.06 + 0.006	0.03 + 0.005	0.07 + 0.04	1 + 1
100V	140.000 0	0.07 + 0.006	0.04 + 0.005	0.22 + 0.04	--
1000V	1000.000	0.09 + 0.01	0.05 + 0.007	--	--

Scale length, integration time, tracking speed

Digits	Display	Integration	Speed	Add Error
7½	6½	3.2s	1/3.2	--
6½	5½	0.4s	2.5/s	--
5½	4½	0.1s	10/s	±1 digit
4½	3½	6.25ms	85/s	±1 digit
3½	3½	1.56ms	100/s	±2 digits

Low Frequency Error

below 1kHz	use ~ Filt.
5 to 10Hz	add 0.25% rdg
3 to 5Hz	add 0.3% rdg
2 to 3Hz	add 0.6% rdg
1.5 to 2Hz	add 1.0% rdg
DC	add 0.1% rdg

Input Impedance:	1MΩ||150 pF
Temp, Coeff, upto 10kHz:	±30 ppm rdg/°C
Sample settling time:	20ms × (digits selected)
~ Filter selected:	400ms × (digits selected)

Maximum Inputs

Autorange:	1kV pk
Commanded range: 0.1, 1V:	350V pk
10, 100, 1000V:	1kV pk
Maximum VxHz:	10^7
Crest Factor at fs:	5:1

FUNCTIONS

Modes: Vdc, Vac, Vac + dc, Filter (ac), Ohms, True Ohms, Ratio

Ranging: Auto or manual

Scale length: 7071: 3½*, 4½, 5½, 6½, 7½
*through remote control.

Additional: Local, Null, Null On, SRQ, Self Test, History forward, History reverse, Compute On/Off, Compute History, History clear, Help, clear results.

Programs:

Ratio	8 subsets
Digital Filter	3 subsets
Scale and offset	
Statistics	6 subsets
Limits	8 subsets
Time, real or elapsed	

History File: 1500 readings numeric only
500 Readings with time, channel mode, History number recircultating or fixed
Selectable dump facility

SYSTEMS USE

The following interfaces are provided as standard.

IEEE 488 (1978)

Provides full talker/listener facilities and remote control of all functions.

Subset: SH1, AH1, T5, TE0, L3, LE0, E1, SR1, RL1, DC1, C0, DT1, PP1

RS232C

Provides full remote control of all functions.

Speed, user selectable:	110 to 9600 bits/s

Scanner

Interface provided for Minate (7010)

Channels:	16 to 128
Pull in and drop out delays:	programmable

Additional control lines

External Sample:	contact closure
Sample complete:	TTL level
Out of limit High:	open collector 40mA
Out of limit Low:	open collector 40mA

SYSTEMS LANGUAGE

The 7071 is programmed by use of ENGLISH words. These may be of a full or shortened form, and conform to recommended practices set out in 1981 draft 'Code and format conventions for use with IEEE standard 488 (1978)'.

A 'HELP' facility is available for ease of programming.

INTERFERENCE REJECTION

Normal Mode Rejection, dc measurement.

7½ to 5½ digits at 50(60) or 400Hz, ± 3%	>70dB

Effective Common Mode Rejection

With 1kΩ imbalance.

DC measurement

7½ to 5½ digits, at 50(60)Hz, ± 3%:	>140dB
7½ to 5½ digits, at 400Hz ± 3%:	>120dB

AC measurement

Rejection of 50/60Hz ± 3%:	>40dB
Maximum permitted common mode:	500V dc or pk

GENERAL

Power Supply

Voltage:	100/120/220/240V +15% −10%
Frequency, automatic sensing:	48 to 52Hz, 57 to 63Hz, 384 to 416Hz
Consumption:	40VA

Safety

Designed in accordance with IEC 348, BS4743 and UL1244

Environment

Operating:	0°C to +45°C
Storage:	−20°C to +70°C
Relative Humidity	90% at 40°C (non condensing)

Dimensions

Height:	88mm (3.5ins)
Width:	432mm (17ins)
Depth:	419mm (16.5ins)
Weight:	8.25kg (19lbs)

Chapter 2
Installation

Contents

		Page No.
1	Voltage Selection	2.2
2	Fuses	2.2
3	Warm-up Procedure After Prolonged Low-Temperature Storage	2.3
4	Rack Mounting	2.4

1 Voltage Selection

The 7071 is fitted with a multi-purpose mains input unit on the rear panel which contains the mains input socket, fuses, voltage selector and filter. Before applying mains power, ensure that the voltage selector is correctly set; 100V, 120V, 200V, or 240V will appear in the small aperture.

The voltage selector must be set as follows:

100V for 90V to 115V ac input
120V for 110V to 135V ac input
200V for 190V to 215V ac input
240V for 230V to 255V ac input

To change the selector:

1. Remove the mains plug from the input socket.
2. Lift the hinged flap.
3. Turn the voltage selector roller block so that the desired voltage shows through the aperture.
4. Check fuses as described below.
5. Close flap.

2 Fuses

There are two fuses mounted below the voltage selector. Both LINE and NEUTRAL are fused with the following fuse values depending upon the voltage selected:

100 and 120V	400mA slo-blo
200 and 240V	200mA slo-blo

To change the fuses, press the arrow in the direction indicated and pull the fuse out.

3 Warm-up Procedure After Prolonged Low-Temperature Storage

For optimum calibration performance the instrument should normally be warmed up for 24 hours in a stable thermal environment. However, if it has been stored below 5°C for long (e.g. during initial shipment or outside in cold weather), use the following special warm-up procedure:

1. Unpack the instrument, but leave the middle box located within the outer box by the foam 'corners' (Fig. 2.1)

2. Set aside the inner box, expanded polystyrene packings, and thermal inertia bottles. These are not used in this procedure

3. Connect a mains lead, and stand the instrument directly inside the middle box

4. Plug in the mains lead, switch on the instrument, and close both middle and outer box covers to form an 'oven' enclosure

5. Leave to stand for 24 hours in this high temperature (~35°C) environment

6. Remove the instrument, place in a stable room temperature environment, and allow to stand powered up a further 24 hours.

The instrument is now ready for accurate use.

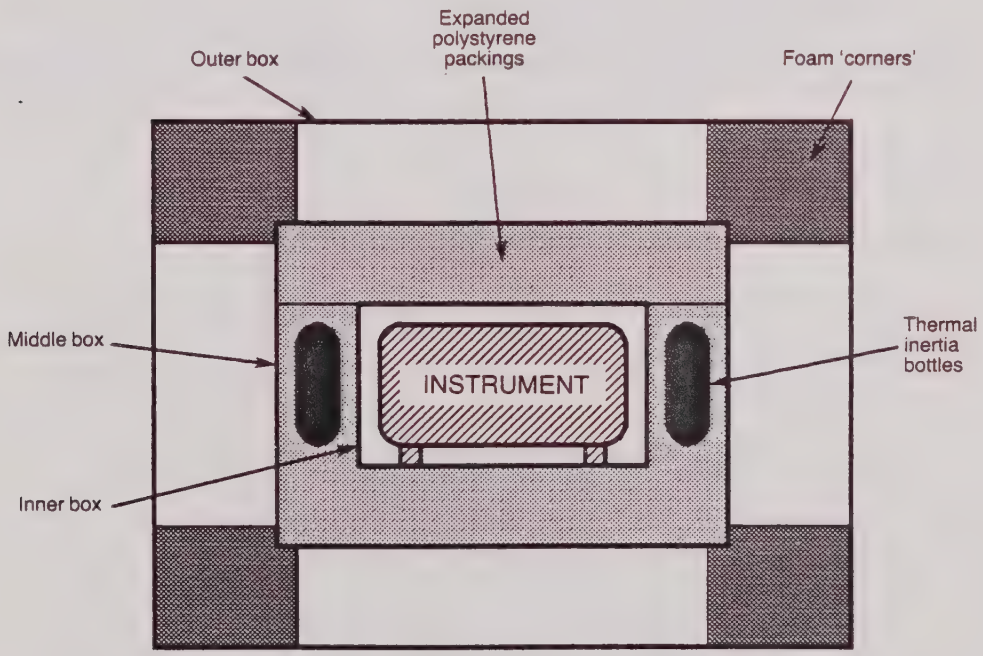


Fig 2.1 *Instrument packaged for shipment (side view)*

4 Rack Mounting

The 7081 can be rack mounted in two ways: either by using fixed rails in the rack to support the underside of the case, or by using telescopic slides to support the 7071 and allow easy withdrawal for servicing.

With either method, the pair of rack mounting brackets included in the accessory kit is substituted for the finisher trims on the 7071. Screws inserted through the brackets and into the rack keep the unit in place.

Note 1: The rack mounting brackets must be used only to prevent the 7071 sliding out of the rack. They are not designed to support the whole weight of the instrument.

Note 2: When the 7071 is rack mounted on telescopic slides, ensure that the rack will not tip over when the sides are fully extended.

4.1 Telescopic Slide Mounting Kit 70759

This slide mounting kit is available from Solartron as an optional accessory, and contains:

a. 1 telescopic slide kit, plus fixings
b. 12 screws, M4x6 panhead, to fix slide inner members to the mounting bars
c. 12 washers, M4 crinkle
d. 2 screws, M6 satin chrome, to fix front panel to rack
e. 2 washers, M6 plain
f. 2 caged nuts, M6, to fix front panel to rack

The kit is suitable only for 30 inch deep IMHOF IMRAK Series 80 or dimensionally similar cabinets.

4.2 Rack Dimensions

The internal rack dimensions required for fitting the 7071 are:

610mm (24ins) deep x 485mm (19 ins) wide for fixed rail mounting, and

760mm (30 ins) deep x 485mm (19 ins) wide for telescopic slide mounting.

4.3 Fitting the Telescopic Slide Mounting Kit

4.3.1 Remove the following items from the unit, as shown in Fig. 2.2:

a. **Finisher Trim** (two off)
Keep the four M4x16 panhead screws and M4 crinkle washers for securing the rack brackets.

b. **Handle** and **Handle Trim**

c. **Side Trim**
Located on the opposite side to the handle, it is normally secured by a pip on the finisher trim, and slides out backwards.

d. **Feet** (four off) and **Tilt Bar**
The tilt bar is secured by the two front feet.

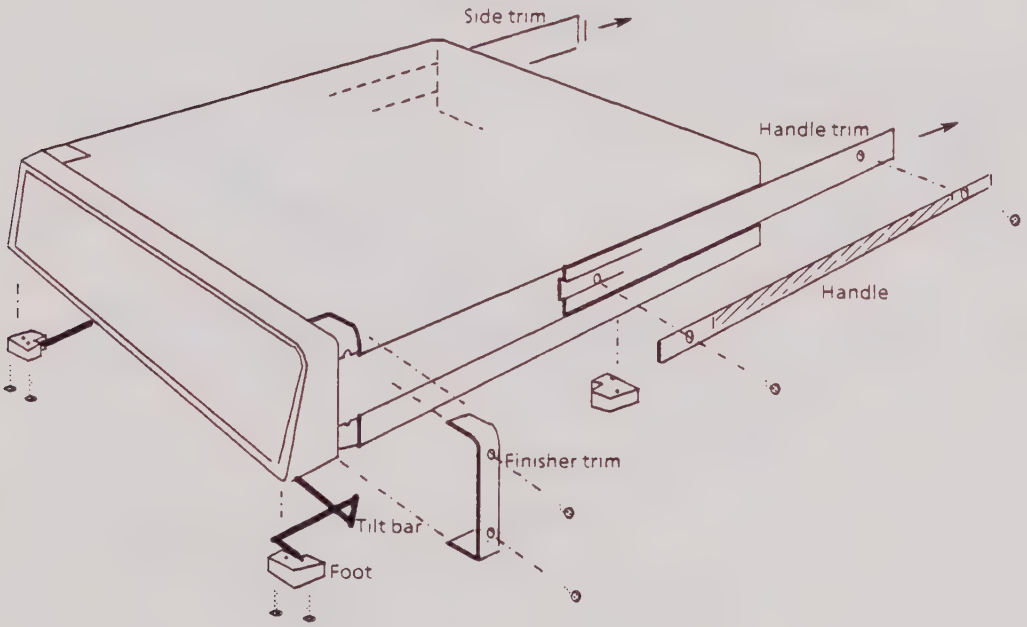


Fig. 2.2 *Removal of trims, handle, feet and tilt bar*

4.3.2 Fit the following items to the unit, as shown in Fig. 2.3:

a. **Rack Mounting Brackets** (two)
Fit rack mounting brackets in place of the finisher trim, using the same fixings.

The brackets may be fitted as illustrated, or with their flanges facing the rear of the 7071, which causes the unit to stand out further in the rack, allowing use of racks too shallow for normal mounting.

b. **Slide Mounting Bar**
The slide mounting bar and fittings are provided with the 7071 accessories. Screw the bar to the chassis in the former position of the handle, using the four M4x12 countersunk screws provided. The bar fits correctly only one way round, with threaded holes nearest the front.

The corresponding mounting bar on the left-hand side of the unit is supplied already fitted behind the side trim; it is slightly narrower than the right-hand bar.

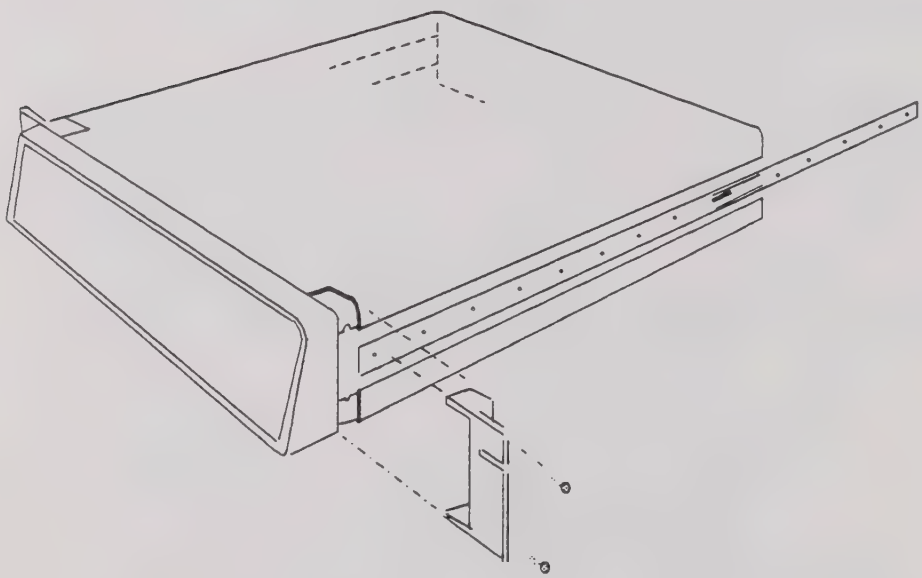


Fig. 2.3 *Fitting mounting brackets and telescopic slide inner members*

c. **Telescopic Slide Inner Members** (two)
The telescopic slides are supplied with inner and outer members slotted together. Slide out the inner member as shown in Fig. 2.4, depressing the locking catch at the halfway point.

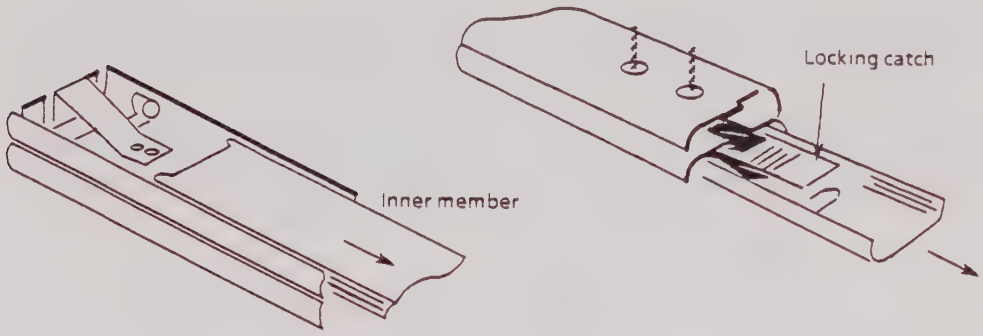


Fig. 2.4 *Separating the inner and outer slide members, prior to fixing*

Screw the slide inner members to the mounting bars, using the 12 M4 x 6 panhead screws supplied, 6 each side.

4.3.3 Fit the following items to the telescopic slide outer members, as shown in Figs. 2.5 and 2.6:

a. **Adjustable Rear Brackets** (two)
Fit one rear bracket to each outer member, but do not fully tighten the screws until the 7071 is fitted into the rack (Section 4.3.6).

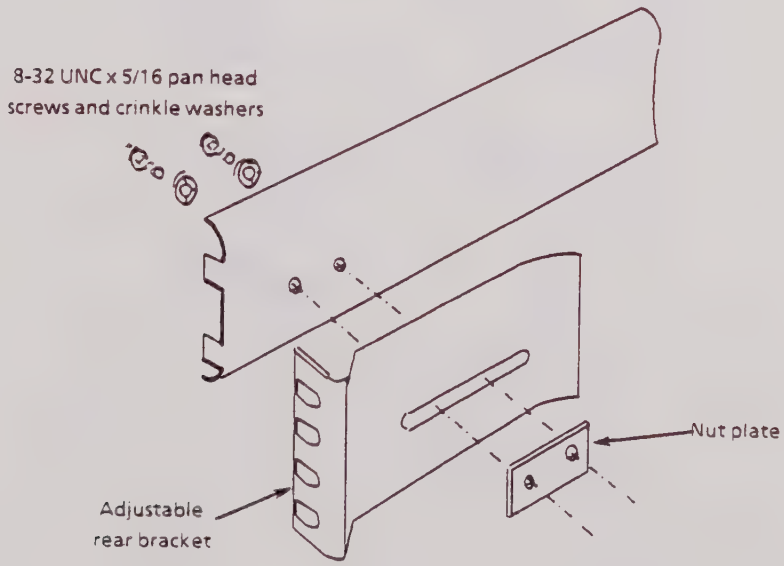


Fig. 2.5 *Fitting a rear bracket*

b. **Fixed Front Brackets** together with **Support Brackets** (two of each).

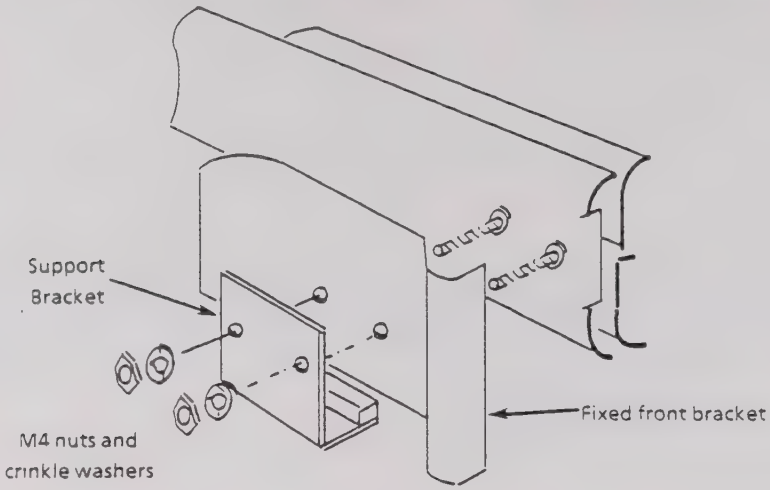


Fig. 2.6 *Fitting a front bracket and support bracket*

4.3.4 Fit the M6 caged nuts for outer slide member and rack slide member and rack mounting bracket fixing into the rack, in the positions shown in Fig. 2.7 How to insert and remove caged nuts is shown in the figure detail.

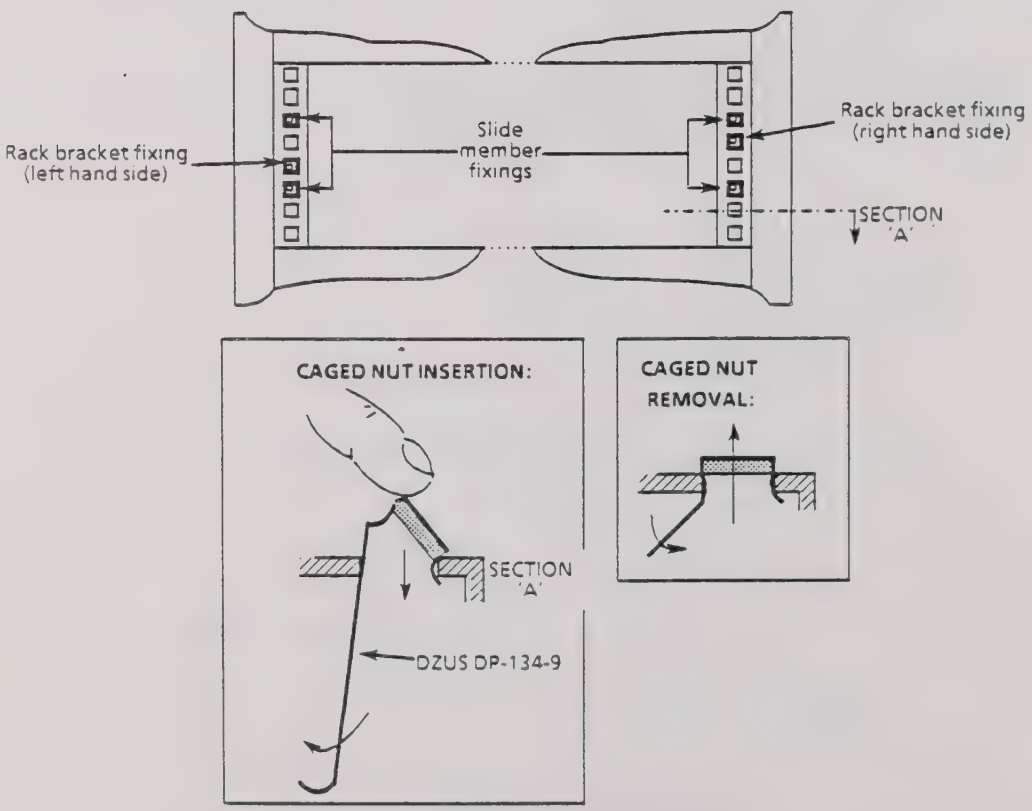


Fig. 2.7 *Caged nut insertion in Imrak Series 80 (and similar) cabinets*

4.3.5 Fit the **Outer Slide Members** (two) to the rack as shown in Fig. 2.8

Note that the tapped holes in the nut plate are positioned off-centre in order to provide maximum lateral adjustment. Fit the plates, as shown, with the holes offset towards the rack exterior.

Fitting one end of an outer member is made easier if the other end is supported, by hooking the bracket at the other end over an M5 screw pushed into the top caged nut.

Tighten the M5 screws securing each member until it is held moderately firmly in the rack, approximately in the centre of its travel. The members must, however, be free enough to take up any adjustment when the 7071 is first fitted into the rack.

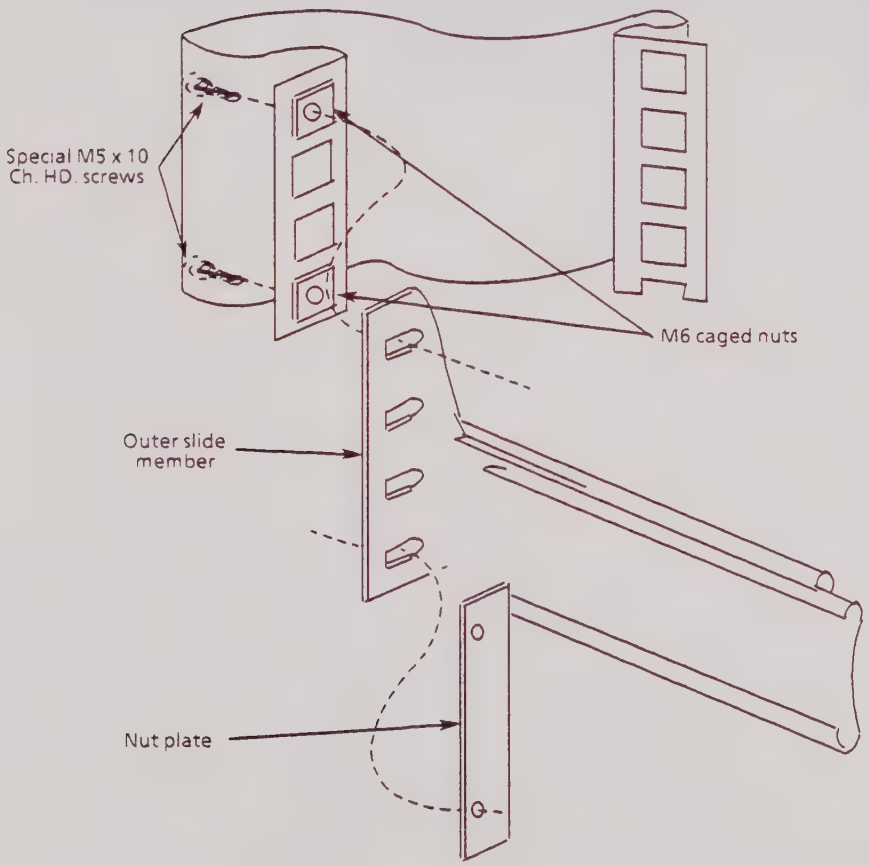


Fig. 2.8 *Fitting the outer slide members into the rack*

4.3.6 Finally, fit the 7071 into the rack, as follows:

a. Offer the 7071 up to the rack and feed the inner telescopic slide members into the outer members, pushing the unit into the rack until the locking catches engage and lock.

b. Depress both catches and push the unit fully into the rack, ensuring that no cables are trapped.

c. Tighten the screws on the outer slide members in the following order:

1. the M5 screws securing the rear bracket to the rack,

2. the M5 screws securing the front bracket to the rack,

3. the 8-32 UNC screws securing the rear bracket to the outer slide member.

Chapter 3
Controls & Displays

Contents

		Page No.
1	The Voltmeter Controls	3.2
2	Front Panel Controls	3.2
3	Shifted Level Controls	3.5
4	Rear Panel Controls	3.6
5.	Displays	3.6

This chapter is intended to familiarise the user with the controls and displays associated with the operation of the voltmeter as a bench instrument.

Some controls have additional functions, for processing. Also some displays are concerned only with the remote control of 7071. Although mentioned here for continuity, more detailed information on remote control can be found in Part 2 of the manual.

1 The Voltmeter Controls

All of the voltmeter controls, with the exception of the mains ON/OFF switch, RS232 Baud rate switches and the GP-IB selector switches, are located on the unit front panel.
An audible tone accompanies each control selection; a short tone for a valid selection and a long tone for an invalid selection. An invalid signal results, if, for example, the NULL control is selected with the voltmeter set to measure an ac function as nulling is a dc facility. Similarly, a long tone resulting from a keyboard selection (other than by pressing local) indicates that the voltmeter may be under REMOTE control.

2 Front Panel Controls

The front panel controls are used to select the following unit operations:

1. Measurement
2. Ranging
3. Scale length
4. Trigger
5. Special functions
6. Input select

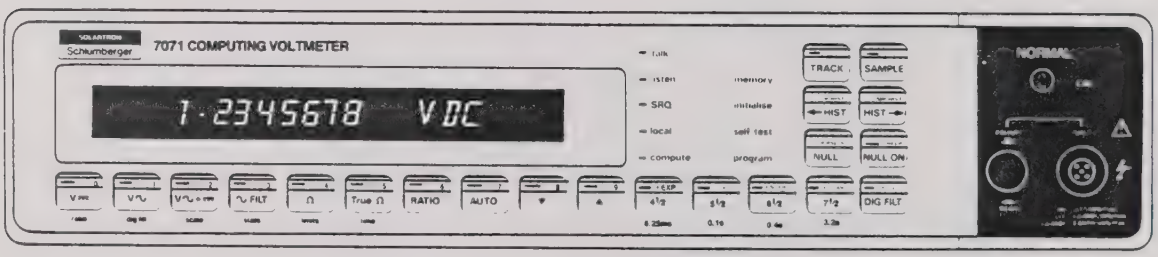


Fig 3.1 *Front Panel*

2.1 Measurement

V⎓ DC Volts
Measures the average dc input over the selected integration time.

V~ AC Volts
Measures the true rms of the ac component of the input over the selected integration time.

V~ + ⎓ AC + DC Volts
Measures the true rms of the total (ac + dc) input over the selected integration time, i.e. $\sqrt{(Vac^2 + Vdc^2)}$.

~FILT
Selects ac filter. This control can be used only in conjunction with the V~ + ⎓ and V~ controls and should be selected for full accuracy below 1kHz.

Ω Resistance
Measures the average resistance over the selected integration time.

True Ω
Measures the resistance eliminating any spurious emfs.

RATIO
Measures the ratio of the unknown input against a reference. (For further details refer to Chapter 4.) The default setting is main/reference.

2.2 Ranging

AUTO
Selects automatic ranging. The unit will select the required range for each measurement taken. Deselection causes the existing range to be held.

▲
Ranges down to a more sensitive range. The unit is therefore set to a specific range.

▼
Ranges up to a less sensitive range. The unit is therefore set to a specific range.

2.3 Scale Length

Control	Example Outputs	Approximate Maximum Output	Integration Time
4½	0.5483, 2.549	1.4000	6.25ms
5½	0.54833, 2.5491	1.40000	0.1s
6½	0.548488, 2.54883	1.400000	0.4s
7½	0.5485005, 2.548854	1.4000000	3.2s

2.4 Trigger

TRACK
Causes continuously updated measurements. Press again to stop measurements.

SAMPLE
Causes a single measurement.

2.5 Special Functions

←HIST
Recalls the last displayed reading. Press again to recall the last but one reading and so on. Up to 1500 readings may be recalled if the file is set to compressed format, or 500 readings if the file is set to expanded format.

HIST→
Operates as ←HIST but recalls the readings in reverse order, i.e. starting from the first reading in the file.

Note: Holding either of the above two controls ON scrolls through the stored values until the control is released at the required value. This facility provides fast access to records.

NULL
Commands the unit to NULL on any selected dc or ohms range. If the AUTO control is in use, all ranges for the chosen measurement function are nulled.

NULL ON
Disables/re-enables a NULL. This control can be used to provide a comparison check on previously nulled ranges. If NULL is in use, the NULL ON annunciator is illuminated.

Note: The unit remembers any nulled range. It is not therefore necessary to re-null after returning from another function.

DIG FILT
Provides digital filtering of the measurements. (For further details, refer to Chapter 4.) The default setting is Walking Window averaging with a sample size of 10.

memory
Places the last displayed numeric value into a specific single slot memory location. The value can be accessed directly and used during program set-up, e.g. as the value *N* in Ratio. To place a display in the memory or to recall a result from the memory, press the memory control. A result will remain in the memory until over-written or until the 7071 is initialised.

initialise
Returns the unit to the initialised state, i.e. vdc, autorange, 6½, local, with all programs off. The Ratio and Digital Filter programs adopt their default settings and both interfaces and the nulling facility are disabled.

self test
Initiates a sequence of tests on the voltmeter internal measuring circuits using known inputs. Checks the ohms drive generator, ac amplifier, dc input amplifier and a-to-d converter. A fail display, e.g. FAIL, TEST 0V, appears if a circuit is faulty. Self test stops at a failure, or displays *PASS* if successful.

program
Causes the program status to be displayed and introduces the keyboard shifted level for program selection and definition. After program definition the control must be pressed again to activate the program. (See Shifted Level Controls).

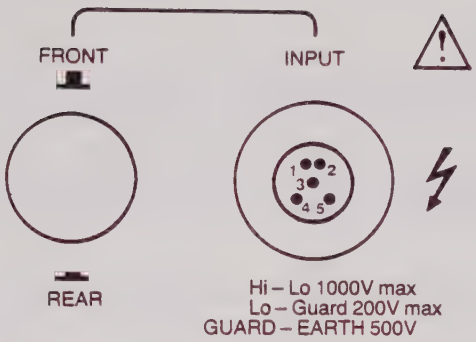
compute
Enables already defined programs to be turned on or off without the need to clear them from the memory.

Note: If compute is pressed to turn the programs off, the RATIO and DIG FILT annunciators may remain on. Under these circumstances, the results will not be processed by these two programs as the compute control overrides the other controls.

SRQ
Permits the user to generate a service request. This control can be used, for example, to indicate to the controller that some local operation has been carried out and that control can now be returned to the controller. Local use of SRQ (usually an automatic voltmeter function) must be enabled via remote control.

local
Returns the voltmeter to local control (from remote), provided that Local Lockout has not been enabled from the controller.

2.6 Input Select



Input pins have the following signal assignment:

1. Ω source Lo
2. Lo
3. Guard
4. Hi
5. Ω source Hi

Selects inputs to be routed either via the front panel connector (push button out) or the rear panel connector (push button in).

3 Shifted Level Controls

For processing, some of the front panel controls lose their face value meanings and assume different functions. These second, or shifted-level, functions become available after the program key has been pressed. Programs, which may be used individually or combined, can be selected from the following using the adjacent controls:

ratio dig filt scale stats limits time

After selection, programs may be entered then defined.

For program definition, the numeric, the •/EXP and the +/− controls are used. Pressing the above (from left to right) will either select the required program option or enable any numeric value plus sign and exponent to be selected as the constant in a program. The invalid tone will advise when no further options are available for the chosen program.

The remaining shifted-level controls are:

ENTER
Enters program(s), options and constants into memory prior to program execution.

CLEAR
Clears either one program or all programs in preparation for a new program definition or run. This control also clears the program constants.

RECALL
Recalls processed results to the display. Applies to Stats, Limits and, in one case only, to Digital Filter programs.

CLR HIST
Clears the contents of the history file.

COMP HIST
Passes the contents of the history file through any activated programs in the chaining order.

CLR RSLTS
Clears any processed results from the program memory.

HELP
Displays the program options available. Refer to Chapter 4 for a list of the messages displayed.

4 Rear Panel Controls

The rear panel controls have the following functions:

MAINS ON/OFF
When ON, applies mains power to the unit, initiates a power-up test sequence and causes trickle charge of the RAM back-up batteries.

GP-IB Interface Selectors
Applicable only when the unit is under remote control via the GP-IB interface. (See Part 2).

5 Displays

When under local control, the voltmeter conveys visual information to the user via the front panel annunciators and the main 14-segment display windows. The audible tone, with its valid or invalid "beep", complements the above two facilities.

5.1 Annunciators

When lit, the push button annunciators indicate some active state, e.g. the Ω annunciator indicates that the voltmeter is primed to measure resistance.

The HIST (history file) and range (▲ and ▼) controls require no annunciation since a change is clearly visible on the main display as it is occurring.

The two nulling controls (NULL and NULL ON) have only one annunciator. When NULL is pressed, the NULL ON annunciator lights after the nulling sequence is completed. Thereafter, NULL ON acts as a switch to either remove the null offset (light off) or to activate it (light on).

The program control has two distinct functions:

1. To introduce shifted-level controls for program selection.
2. To return from programming to ordinary measurement mode.

Executing operation 2 above will cause the 'compute' annunciator to light indicating that programs are defined for use.

Two other annunciators on the front panel are associated only with remote control and have the following functions when lit:

TALK – indicates that the voltmeter is primed to send, or is sending data via the GP-IB interface.

LISTEN – indicates that the voltmeter is primed to receive or is receiving data via the GP-IB interface.

It is possible for the two remaining annunciators, 'SRQ' and 'local' to be activated either by front panel operation or by remote control.

The reasons why a service request (SRQ) is raised are varied but, usually, SRQ is raised automatically as a result of some action (or inaction) over the interface. It is possible for the user to raise an SRQ by pressing the SRQ control.

When the 'local' annunciator is lit, the voltmeter may be controlled fully via the front panel; otherwise ('local' annunciator out) only remote control is possible. Under certain conditions, local control may be re-asserted by pressing local.

5.2 Display

A 20-character, alpha-numeric display is used to indicate measurement values, program results and messages. A fixed minus sign appears in the left-hand window if the display quantity is negative.

Table 3.1 lists the 7071 display messages that may appear when the unit is being operated via the front panel.

Table 3.1 *Local Messages*

Message	Reason for display
WAIT @ F	Appears during 7071 power-up or initialise sequence. If message remains displayed, a fault exists.
RESUMED	7071 has been successfully powered-up.
INITIALISED	7071 has been initialised either by power-up or by pressing the initialise control.
MAINS FAULT DUMP FAIL NVM FAIL CAL INCOMPLETE	A fault has occured at power-up.
PASS	Self test has been successful.
FAIL, TEST 0VDC FAIL, TEST 10VDC FAIL, TEST OHMS FAIL, TEST AC	7071 has failed part of the self test.
COMPLETE	Nulling or history compute successfully completed.
NULL TOO HIGH	Nulling unsuccessful.
NULLING n	Nulling of range n in operation.
ARMED	Time program ready for use.
READY	Program(s) ready for use.
COMPUTING	History compute in operation.
INSUFFICIENT HISTORY	Not enough history in the file to complete a history compute operation.
NO PROGRAMS ON	There are no programs enabled and, therefore, history compute has no meaning.

Note: A full list of the responses displayed when the HELP control is pressed is given in Chapter 4.

5.3 Overload Indications

An overload condition is indicated by a flashing display. Usually this occurs when the value at the voltmeter's input terminals becomes too large for a given selected range. Selecting a higher (less sensitive) range, or changing to Autorange, will cause a normal display to return. The instrument automatically protects itself up to the specified maximum input, i.e. 350V if range is fixed on 0.1, 1 or 10V.

Overload may be indicated even when a measurement has not been requested, since the a-to-d converter is always assessing the input.

Chapter 4
Local Operation

Contents

		Page No.
1	Power-Up	4.2
2	Calibration Transfer	4.3
3	Self Test	4.3
4	Operation	4.4
5	Nulling	4.5
6	Processing	4.5
7	Help Control	4.19
8	Clearing Programs	4.20
9	Computing History	4.20

This chapter covers the basic operation techniques for the unit including program initiation and use.

1 Power-Up

When the voltmeter is switched ON, a power-up test sequence automatically commences. This checks the voltmeter's two microprocessors and also its battery back-up (for internal calibration memory (RAM)).

The full sequence should conclude with the display:

RESUMED

indicating that the test sequence has been concluded satisfactorily and that the voltmeter may resume normal operation, i.e. any program constants or history file contents entered before the unit was switched off are retained in the memory.

During the test sequence, the display:

WAIT @ F

should appear momentarily then clear. A failure to clear indicates that the "floating" microprocessor (hence "F") has failed to come out of the reset condition and thus a fault exists. The microprocessor is said to be "floating" because the supply voltages to that side of the unit are tied to the input and therefore subject to some variation.

If, instead of RESUMED, the following appears in the display:

INITIALISED

battery back-up has been unsatisfactory, i.e. the unit has been switched off for too long to retain any history file contents, programs etc.

If

DISPLAY OFF

appears, the display has been turned off via remote control. In order to receive any results, messages, etc. via the front panel, the 7071 must be initialised by pressing the front panel initialise control or the display must be turned on again using a remote control device.

If the unit has a fault, one of the following messages may appear in the display after WAIT @ F:

MAINS FAULT, DUMP FAIL, NVM FAIL, CAL INCOMPLETE

The first of these messages indicates that the "floating" microprocessor has been unable to identify the mains frequency. The second, third and fourth messages relate to the calibration constants as described in the following section.

Once the power-up sequence is complete, the unit adopts the volts dc, auto range, 6½ mode.

2 Calibration Transfer

The calibration constants are stored in a Non-Volatile Memory (NVM) situated on the "floating" side of the voltmeter. There are two identical pages of constants in the NVM so that, if a fault occurs on one page, the other can still be used.

At power-up or initialise, the calibration constants are transferred from the NVM into battery-backed RAM on the "earthy" side. This transfer is performed to reduce the access required to the NVM and hence decrease the possibility of corruption of the constants. When the constants are read out of the NVM, a checksum character is computed and compared to the character in the NVM. Each page has its own checksum and, if the page is correct, the result of the comparison will be zero. The NVM checksum has an offset value so that it can distinguish between a valid result and an "all zeros" result produced when the page is empty.

If page one of the NVM is incorrect, page two is checked and the message NVM FAIL displayed. If page two is incorrect, it will still be transferred to the RAM. The microprocessor checks that the RAM has been given the correct number of constants and, if there is an error, DUMP FAIL is displayed. If any of the constants are incorrect, the microprocessor substitutes the default values and the message CAL INCOMPLETE is displayed.

The voltmeter can still be used, if any of these calibration messages appear, but recalibration is required for precision work.

3 Self Test

A unit self test can be initiated by pressing the self test control. During the self test, the voltmeter internal measuring circuits are checked using known inputs. The test sequence is as follows:

1. Press self test.

2. Observe the following displays:

   TEST 0V
   TEST 10V
   TEST OHMS
   TEST VAC

3. The sequence is completed with:

   * * * * * PASS * * * * *

   if all the circuits are functioning correctly.

In the event of a failure, one of the displays listed below will appear.

FAIL, TEST 0V – indicates a failure in the 0V circuitry.

FAIL, TEST 10V – indicates a failure in the dc measurement circuitry.

FAIL, TEST OHMS – indicates a failure in the circuitry used to measure resistance.

FAIL, TEST VAC – indicates a failure in the ac measurement circuitry.

All self testing stops at a failure.

If the voltmeter fails the 0V or 10V test, it should not be used but, if it fails the ohms or ac test, it can be used, if absolutely necessary, for dc measurement only.

4 Operation

Normal measurement flow is presented in Figure 4.1

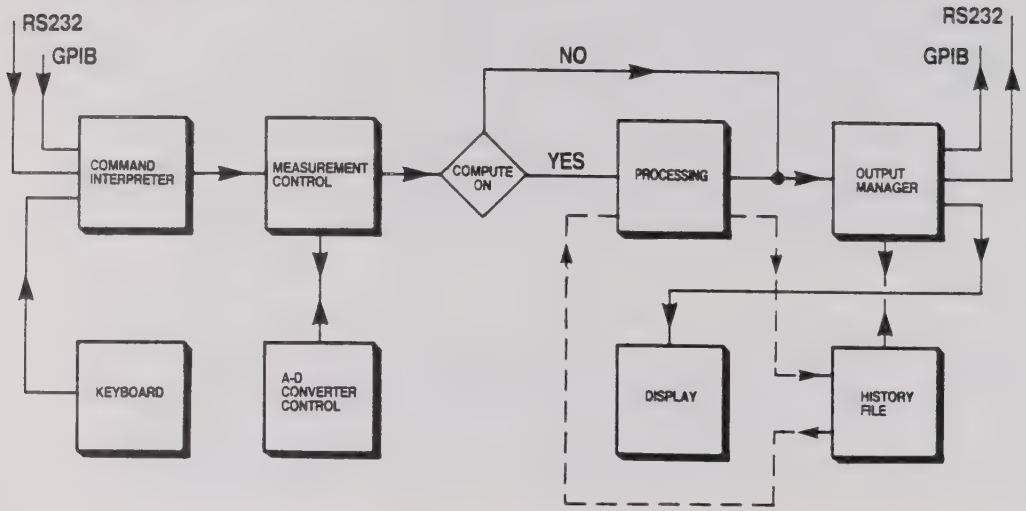


Fig 4.1 *Normal Measurement Flow*

If the unit is to be used, via the front panel, to take individual measurements, the following procedures should be used.

1. Once the unit has been powered-up and a power-up test completed, press the relevant measurement control, e.g. V⎓, V~ etc. (It is not necessary to press the dc control (V⎓) if the unit is in the powered-up or initialised state).

2. Select the required scale length, i.e. 4½, 5½, 6½ or 7½.

4. Select manual range, if required, using the ▲ or ▼ controls.

4. Connect the test source to either the front or rear panel connector, ensuring that the Input Select switch is in the correct position, i.e. out for front panel connector, in for rear panel connector.

5. Press SAMPLE for each reading required or select TRACK for repetitive readings.

For any measurement function the user may select Digital Filter.

Before generating a new command into the system, the front panel keyboard checks on the pressure of work and amount of pending inputs, returning an invalid tone if conditions are unsatisfactory, e.g. if repeated samples are requested on 6½ or higher, the 7071 cannot generate results as fast as they are requested and a backlog of trigger commands builds up until, eventually, the invalid tone is heard.

Under certain conditions, controls are rendered invalid to prevent potential confusion, e.g.

1. When measuring under clock control, most of the controls are disabled. This is because new measurement setting commands cannot be actioned until the present measurement command has been completed and so there would be no status display/annunciator feedback or change to the new setting for what could be a very long time.

2. When computing history, the prompting mechanism (on error or completion) requires that no further input is generated until the process is complete. To ensure this, most controls are disabled whilst the computing process is being carried out.

5 Nulling

The NULL facility allows offsets during a measurement sequence to be removed from the result. For example, the resistance of test probes could affect the accuracy of a measurement but, by using the NULL facility, this can be allowed for.

When the NULL control is pressed, the message:

NULLING n

appears, where n=0.1, 1.0, 10, 100, 1000, 10 ↑ 4 depending upon the range being nulled.

Upon completion of the null sequence, the message:

COMPLETE

appears in the display.

If the NULL is unsuccessful,

NULL TOO HIGH

appears.

6 Processing

The programs available for the 7071 are:

Ratio
Digital Filter
Scale
Statistics
Limits
Time

The programs have a specific "chaining" order, i.e. result flow order. Therefore a result input into a program may be a result derived from a previous program as shown in Figure 4.2.

If programs are required in a different order to the fixed order, the COMP HIST facility should be used, as shown below.

To calculate the current in a circuit for multiple values of fixed resistances:

1. Clear the history file by pressing the CLR HIST control.

2. Set up the Scale program for m=3, c=0 and activate the program.

3. Set the voltmeter to measure True Ω.

4. Press the SAMPLE control to measure and process the required number of results.

5. When the measurements are completed, clear the Scale program by pressing program, scale, CLEAR.

6. Set up and activate the Ratio program for *N*/Main with *N* equal to the known circuit voltage.

7. Press the COMP HIST control.

8. The results displayed will be equal to: known voltage / 3 × measured resistances.

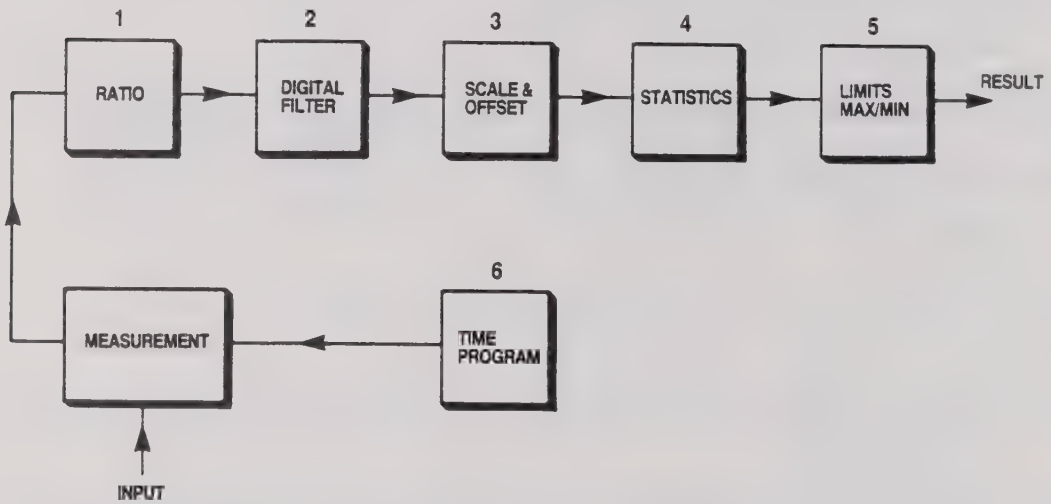


Fig 4.2 *Program Chaining Order*

6.1 Ratio Program

Ratio has a front panel control, which has the effect of turning the program on or off. Its mode of operation, however, may be changed via the program control. The modes available are:

Main/reference dB, i.e. *x*/Ref.dB
Reference/main dB, Ref./*x*dB
Main/reference, i.e. *x*/Ref.
Reference/main, i.e. Ref./*x*
Main/N dB, i.e. *x*/*N*dB
N/main dB, i.e. *N*/*x*dB
Main/N, i.e. *x*/*N*
N/main, i.e. *N*/*x*
where *x* is the input value.

'Main' refers to the input terminals (front or rear panel) and 'Reference' to the reference or ratio terminals (rear panel). *N* is a user defined constant. The default setting for the program is main/reference, which is adopted on initialise.

The maximum permitted input for the reference terminals is ± 14V dc but, using the memory, the unit can be used to ratio volts ac and resistance.

To ratio resistance values, for example, the following sequence could be used.

1. Measure resistance 1 (R1) and store the result in the unit memory.
2. Set up the Ratio program using the memory contents as the value *N* in the program.
3. Measure resistance 2 (R2) using the Ratio program. Results of R2/R1, or R1/R2 can be obtained.

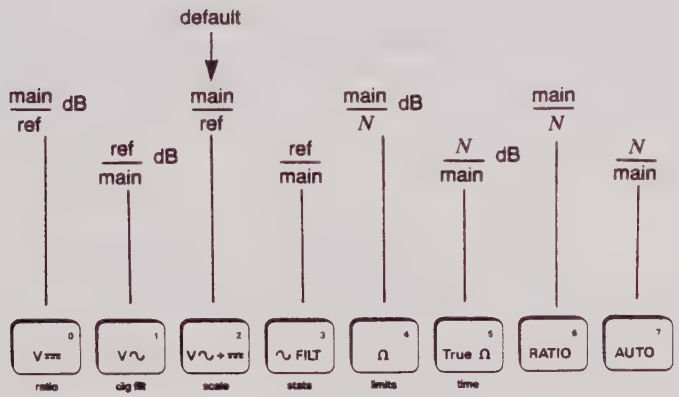
This program can also be used to enable the instrument to measure current, for example in a resistive circuit:

1. Measure the resistance (R) in the circuit, using the True Ω control, and store the result in the 7071 memory.
2. Set up the Ratio program for Main/*N* with the unit memory contents as *N*.
3. Measure the voltage (V) in the circuit using the Ratio program. This will give the result V/R, i.e. current (I).

Program Definition

To access the Ratio program, press program, ratio, ENTER.

The program mode is set by pressing one of the controls shown below followed by ENTER.



The value for *N* is keyed in or obtained from memory.

If required, define the value for *N* and press ENTER.

To activate the program, press the program control.

READY appears in the display and the compute annunciator lights.

Readings can be taken by pressing the SAMPLE or TRACK control.

To deactivate the program, press compute.

6.2 Digital Filter Program

The Digital Filter averaging program has three modes of operation:

Continuous averaging
Simple averaging
Walking window averaging

In continuous averaging, an updated average is output for every input.

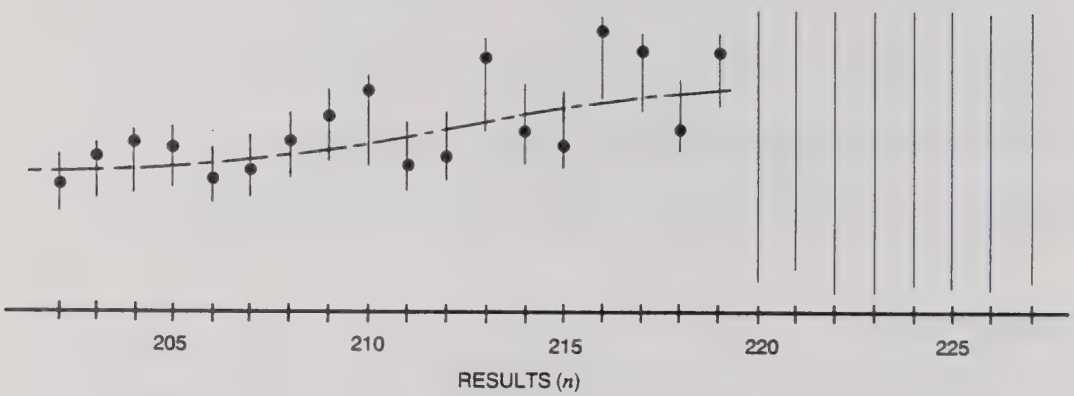


Fig 4.3 *Continuous averaging*

Readings can be taken using either the SAMPLE or TRACK controls, the difference being that the TRACK control takes measurements at fixed time intervals, whereas the SAMPLE control can be pressed at varying time intervals depending upon the user's requirements. If the TRACK control is used, the program has the capability of producing a continuously updated average for up to 1.37 years before the unit runs out of computing ability owing to the increasing size of the numbers involved.

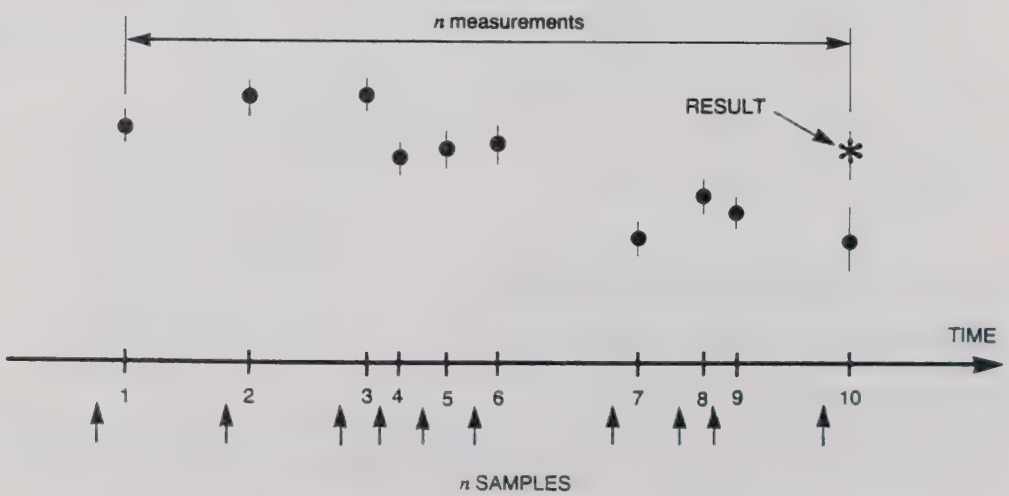


Fig 4.4 *Simple Average of* n *Measurements (Sample Control Used)*

In simple averaging, one average result is produced for each sample size (n). The sample size is user definable and has a maximum value of 1E18. A result does not appear on the display until n readings have been taken, therefore, after each reading, (as a result of pressing the SAMPLE control) the number of samples to go is displayed, finally replacing $n = 1$ with the result. The procedure then repeats itself for another n readings. When using the TRACK control the number of samples to go is not displayed.

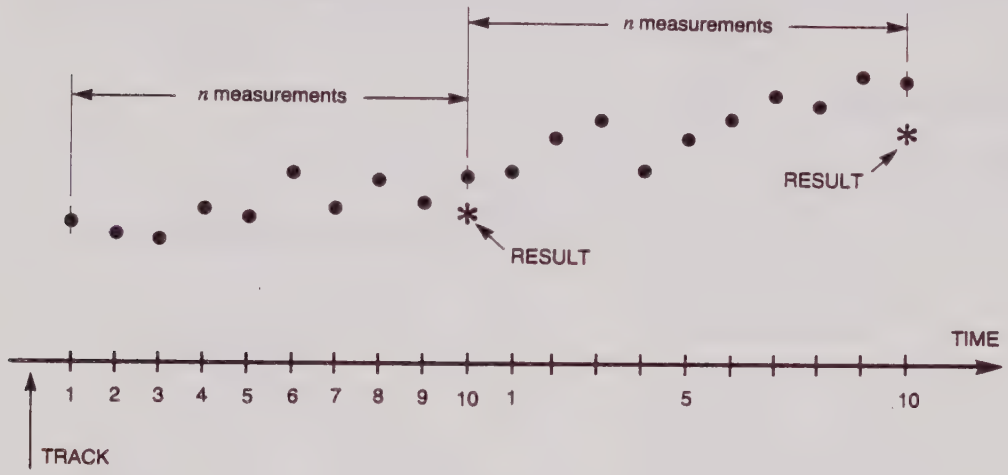


Fig 4.5 *Simple Average of* n *Measurements (Track Control Used)*

In walking window averaging, the sample window used to produce the average result consists of the last n readings where n is the user defined sample size. Therefore, once the sample size has been fulfilled, an average result is produced for every new input. The maximum sample size for this mode is 16. If a sample size > 16 is set, the program will default to a sample size of 16.

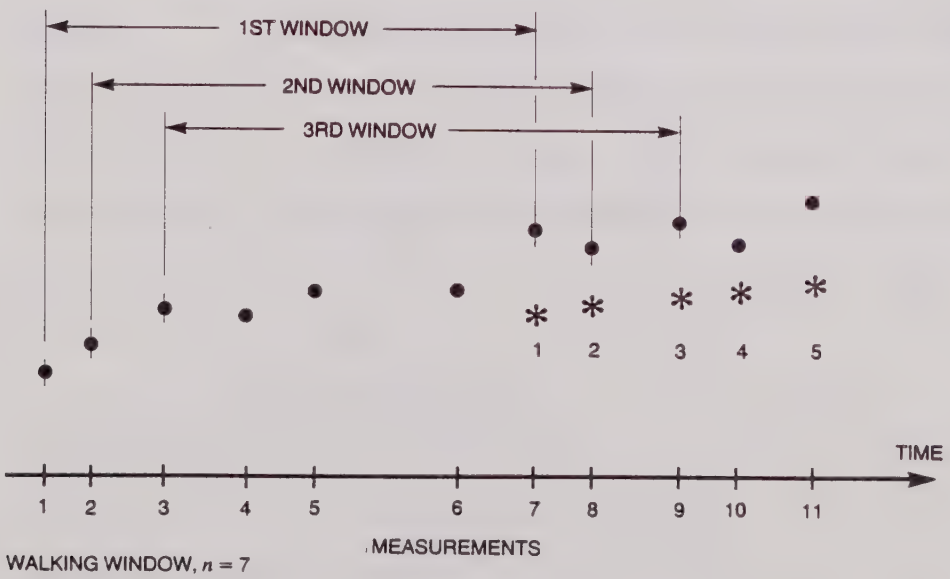


Fig 4.6 *Walking Window Averaging*

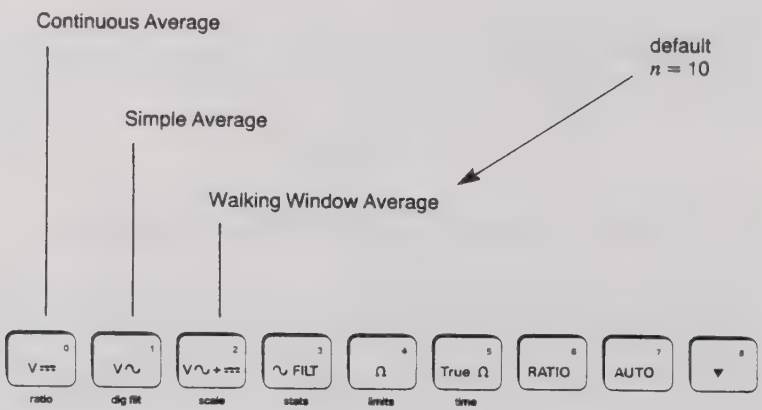
A result does not appear on the display until *n* readings have been taken. Therefore, after each reading taken using the SAMPLE control, the number of samples to go is displayed until the window is full. The result is then displayed. The sample count down does not appear again, as the window is always full, unless the window is reset or cleared.

Digital Filter has a front panel control, which enables the user to turn the program on and off directly. The mode of operation and, if applicable, the sample size may be changed via the program control. The program default setting, which is adopted on initialise, is walking window averaging with a sample size of 10.

Program Definition

To access the Digital Filter program, press program, dig filt, ENTER.

The program mode is set by pressing one of the controls shown below followed by ENTER.



Define the sample or window size and press ENTER, if required.

To activate the program, press the program control.

READY appears in the display and the compute annunciator lights.

Readings can be taken by pressing the SAMPLE or TRACK control.

To deactivate the program, press compute.

6.3 Scale Program

The Scale program provides:

$$y = mx + c$$

where y is the processed result, x the input, and m and c user defined constants.

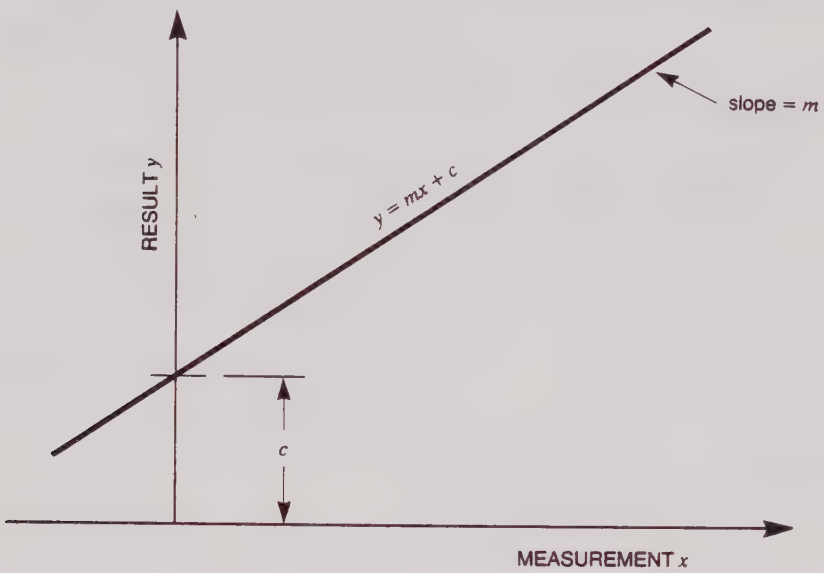


Fig 4.7 *Scale and Offset*

Both m and c may be taken from memory thus enabling a measured value (e.g. of an offset) to be used.

Readings can be taken using either the SAMPLE or TRACK controls.

Program Definition

To access the Scale program, press program, scale, ENTER.

Set the required value for m. Press ENTER.

Set the required value for c. Press ENTER.

To activate the program, press the program control.

READY appears in the display and the compute annunciator lights.

Readings can be taken by pressing the SAMPLE or TRACK control.

To deactivate the program, press compute.

6.4 Statistics Program

The Statistics program can be used in either continuous or window mode.

In continuous mode, the running variables are constantly updated and a result is output for every input.

In window mode, the result is derived from a user defined sample size up to a maximum of 1E18. After the result has been produced, the variables are reset and a new sample collected.

Both modes may be configured to pass on any of the following outputs:

Normal, i.e. x (reading passed on unaltered)
Number so far, i.e. n (number of samples collected so far)

Average, i.e. $\bar{x} = \frac{1}{n} \sum_{i=1}^{n} x_i$

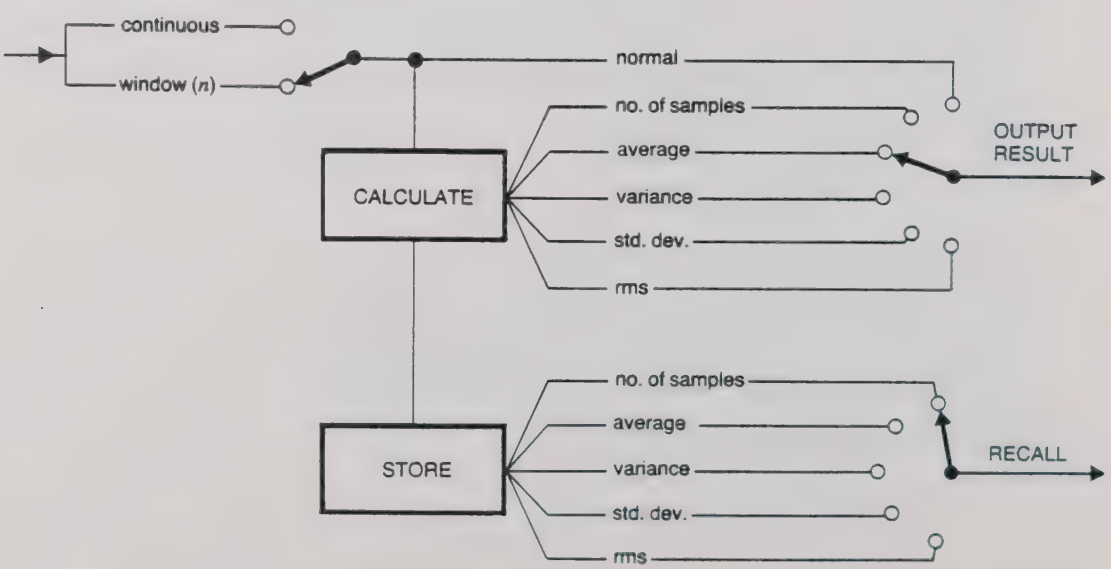
Variance, i.e. $\frac{1}{n} \sum_{i=1}^{n} (x_i - \bar{x})^2$

Standard Deviation, i.e. $\sqrt{\frac{1}{n} \sum_{i=1}^{n} (x_i - \bar{x})^2}$

Root mean square, i.e. $\sqrt{\frac{1}{n} \sum_{i=1}^{n} x_i^2}$

All of the outputs, with the exception of 'Normal', are stored in the unit's program memory and can be recalled at any time during the program's life by pressing the RECALL control.

Readings can be taken for this program using either the SAMPLE or TRACK controls. However, when in window mode, a number of samples are required before a result is produced. Therefore, a sample count down is displayed to give the user an indication of how many more readings are required to produce a result.



Note: The standard deviation and variance given in the Statistics program are the standard deviation and variance of the actual sample taken. If a predicted variance of a much larger sample is required, the equation:

$$Variance = \frac{1}{n-1} \sum_{i=1}^{n} (x_i - \bar{x})^2$$

should be used. This can be calculated using both the Statistics and Ratio programs in the following way:

1. Clear the history file by pressing the CLR HIST control.
2. Set up the Statistics program for a variance output and activate the program.
3. Take the required number of measurements.
4. Clear the Statistics program by pressing program, stats, CLEAR.
5. Set up and activate the Ratio program for Main/N with $N = (n-1)/n$ where n is the sample size used in the Statistics program.
6. Press the COMP HIST control.
7. The reading displayed will be equal to:

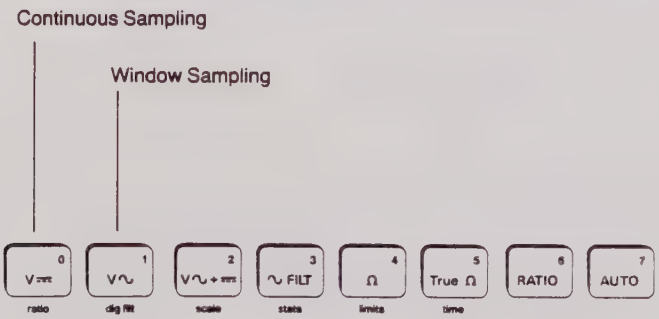
$$\frac{1}{n-1} \sum_{i=1}^{n} (x_i - \bar{x})^2$$

i.e. the variance of the total population.

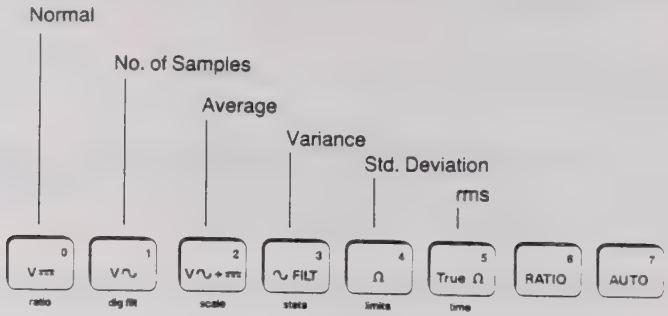
Program Definition

To access the Statistics program, press program, stats, ENTER.

The program mode is set by pressing one of the controls shown below followed by ENTER.



To define the output, press one of the controls shown below followed by ENTER.



To activate the program, press the program control.

READY appears in the display and the compute annunciator lights.

Readings can be taken by pressing the SAMPLE or TRACK control.

To deactivate the program, press compute.

Recall

To recall the results stored in the program memory, press program, stats, RECALL.

Press the RECALL control to scroll through the results, which are displayed in the following order:-

Number of samples
Average
Variance
Standard Deviation
Root Mean Square

To return to the normal measurement mode, press program.

6.5 Limits Program

This program can be used in both continuous and window mode.

In continuous mode, the results are constantly updated and an output result is displayed for every input.

In window mode, one result is produced for each sample size. The sample size is user definable up to a maximum of 1E18.

The output of the program may be configured to be any of the following:

Normal, i.e. x (reading passed on unaltered)
Number high, i.e. $n >$ Hi limit (number above high limit)
Number low, i.e. $n <$ Lo limit (number below low limit)
Number no go, i.e. Hi $< n <$ Lo (number out of limits)
Number go, i.e. Lo $\leqslant n \leqslant$ Hi (number within limits)
Max. value, i.e. Max. x found
Min. value, i.e. Min. x found
Peak to Peak value, i.e. Max. x − Min. x
High results, i.e. $x >$ Hi (only high results output)
Low results, i.e. $x <$ Lo (only low results output)
No Go results, i.e. Hi $< x <$ Lo (only out of limits results output)
Go results, i.e. Lo $\leqslant x \leqslant$ Hi (only within limits results output)

The unit stores the number of high, low, go and no go results, the max., min. and peak to peak values in the program memory. These results can be recalled at any time during the program's life by pressing the RECALL control.

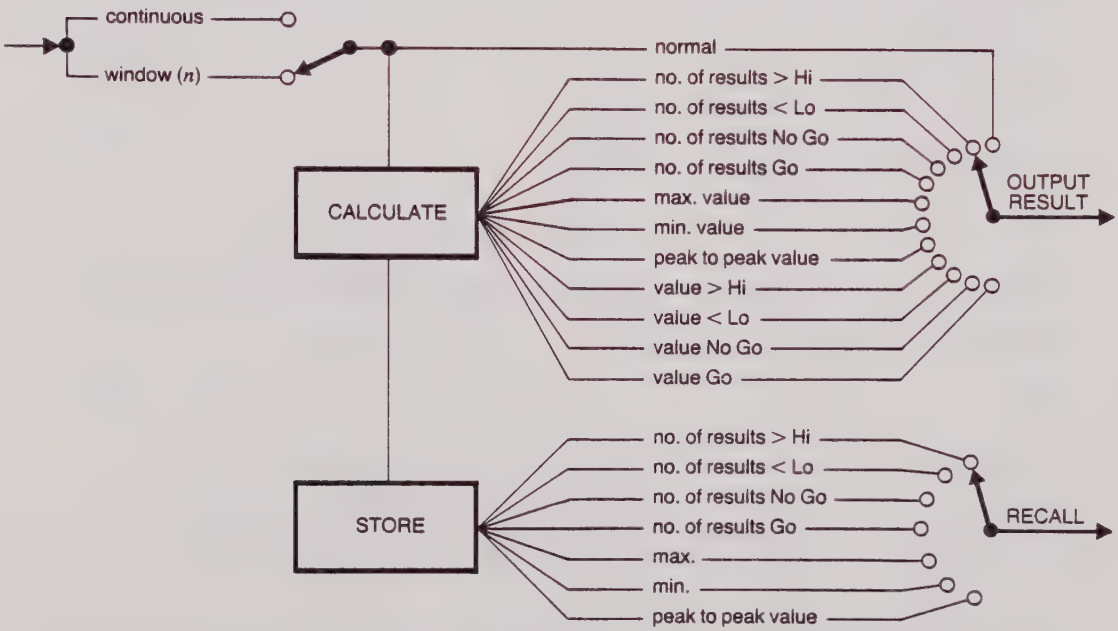


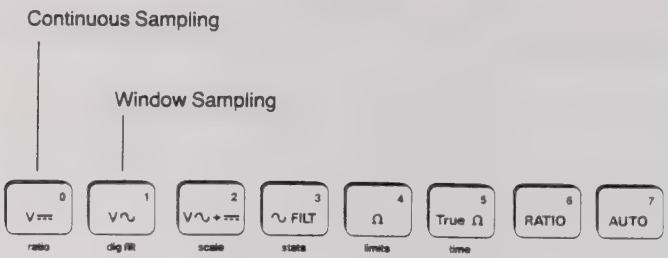
Fig 4.9 *Limits Program*

Measurements for the Limits program can be taken using either the SAMPLE or TRACK controls. However, if the program is configured for window mode, several measurements are required before an output is displayed. In this instance, a sample count down is displayed, in response to the SAMPLE control, which finally replaces $n = 1$ with the result. The process then repeats itself for another n measurements

Program Definition

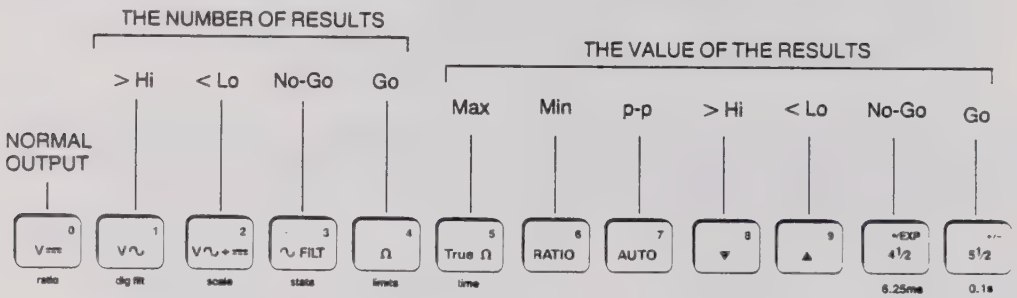
To access the Limits program, press program, limits, ENTER.

The program mode is set by pressing one of the controls shown below followed by ENTER.



Enter the sample size, high and low limits, if required.

To define the output, press one of the controls shown below followed by ENTER.



Results equal to Hi or Lo Limit are treated as in limit (Go).

To activate the program, press the program control.

READY appears in the display and the compute annunciator lights.

Readings can be taken by pressing the SAMPLE or TRACK control.

To deactivate the program, press compute.

Recall

To recall the results stored in the program memory, press program, limits, RECALL.

Press the RECALL control to scroll through the results, which are displayed in the following order:-

Number of results > Hi
Number of results < Lo
Number of results No Go
Number of results Go
Maximum value
Minimum value
Peak to peak value

To return to the normal measurement mode, press program.

6.6 Time program

The Time program is a measurement control function and not a processing function. Its main object is to enable the unit to take automatic measurements under clock control. The compute annunciator does not light when the Time program is in use.

Two modes are available for the program:

Real Time
Elapsed Time

When in the real time mode, the begin and end times for the program must be set to a time of day, e.g. BEGIN 11,55,31.6,01, END 11,58,31.6,01.

In the elapsed time mode, the begin time indicates the time between the moment the user presses the SAMPLE control and the moment the voltmeter makes the first measurement. The end time indicates the period over which the unit will continue to take measurements.

In both modes, the interval time denotes the time between individual measurements

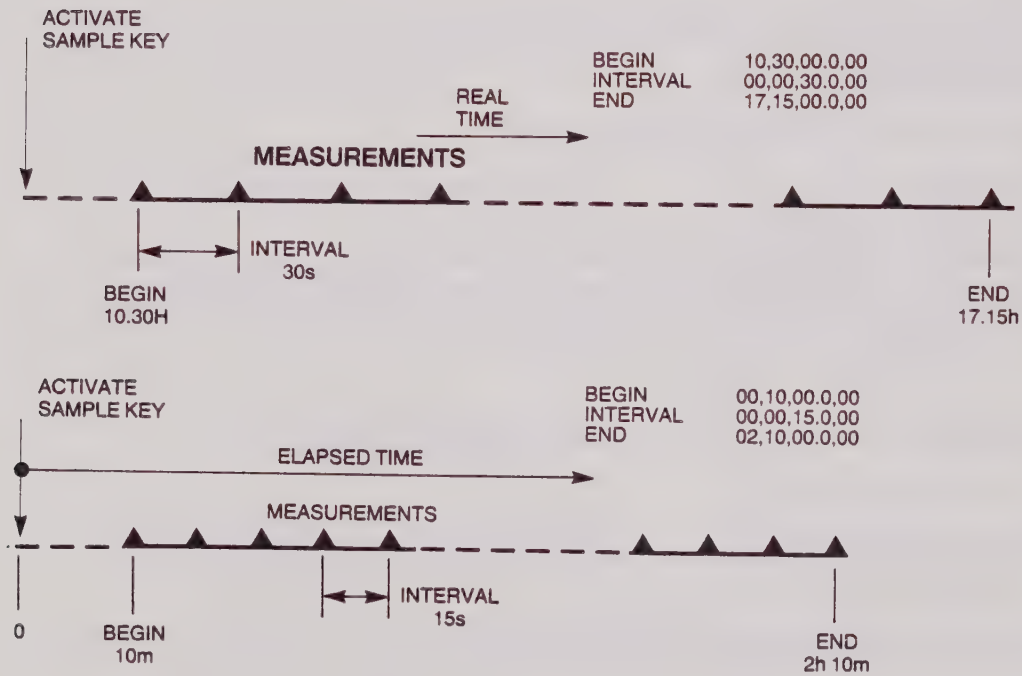


Fig 4.10 *Time Program*

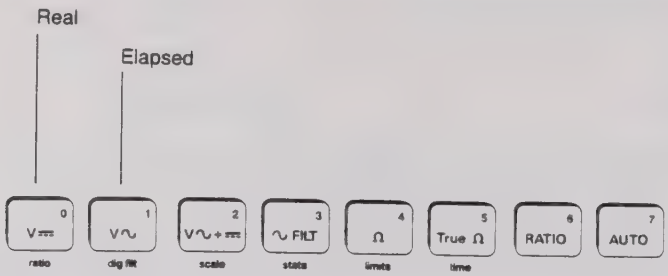
The values should be entered in hours, minutes, seconds, tenths of seconds and elapsed days format.

The TRACK control cannot be used with this program.

Program Definition

To access the Time program, press program, time, ENTER.

The program mode is set by pressing one of the controls shown below followed by ENTER.



Define the values for the begin, interval, end and time of day. Follow each time setting by pressing the ENTER control.

To activate the program, press the program control.

ARMED appears in the display.

Press the SAMPLE control to begin measurements.

Time of Day

It is possible to set the Time of day in 7071 using the Time program as time of day appears after the begin, interval and end times. Therefore, if begin, interval and end are to be 'unchanged' but time of day is to be altered, the following procedure should be adopted:

1. Press program, time, ENTER.
2. Press the V⎓ control, to denote real time, followed by ENTER.
3. Press ENTER three times.
4. Define the time of day required in hours, minutes format, e.g. 11,15, followed by pressing the ENTER control.
5. To activate the setting, press the program control.

7 HELP Control

The HELP control can be used at any time during program definition to display the options available. Refer to Table 4.1 for a list of the messages displayed.

Table 4.1 *Help Messages*

Display Message	Occurence/Use	Definition
Select 0 →5 EN RE PRO	HELP control pressed immediately after program control	Press control 0 to 5, ENTER RECALL or program
0 → RECALL + MEMORY	To set Limits window, high *or low, Scale c* or *m*, Ratio *N*, Digital Filter window or Statistics window	Press controls 0 to 9, •/ EXP, +/−, ENTER, CLEAR, RECALL or memory
0 →9 ENT HH,MM,SS-T,DD	To set Time Begin, Interval or End	Press controls 0 to 9, followed by ENTER, in hours, minutes, seconds, tenths of seconds, days format
0 →9 ENTER HH, MM	To set Time now	Press controls 0 to 9, followed by ENTER, in hours, minutes format
SELECT 0 → +/− ENTER	To set Limits output	Press control 0 to 9, •/EXP or +/− followed by ENTER
SELECT 0 →5 ENTER	To set Statistics output	Press control 0 to 5, followed by ENTER
SELECT 0 →7 ENTER	To set Ratio mode	Press control 0 to 7, followed by ENTER
SELECT 0 →2 ENTER	To set Digital Filter mode	Press control 0 to 2, followed by ENTER
SELECT 0 →1 ENTER	To set Statistics, Limits or Time mode	Press control 0 to 1, followed by ENTER
RECALL PROGRAM	After results displayed	Press RECALL to access next result or program to exit from results sequence.

8 Clearing Programs

Once the programs have been set up, they can be turned on or off, as required, by pressing the compute control. Also, any results stored in the program memory can be cleared by pressing program followed by the CLR RSLTS control. The programs remain unaffected.

If all the defined programs are no longer required, they can be cleared by pressing program and then CLEAR. To clear individual programs, for example the Ratio program, press program, ratio, CLEAR. Any other defined programs will remain intact.

9 Computing History

The contents of the history file can be passed through any of the programs by setting up the programs required and then pressing the COMP HIST control. For example, in order to ratio a number of results against a constant the following procedure could be adopted:

1. Clear the history file by pressing the CLR HIST control.

2. Set up the voltmeter to measure, for example, volts dc, 7½, auto and press the SAMPLE control to measure the required number of inputs.

3. Set up the Ratio program for Main/*N* and activate the program, ensuring that the required value for *N* is entered

4. Press the COMP HIST control.

5. The results displayed will be equal to: measured voltages/constant(*N*)

The processed results are placed in the history file.

Appendix 1
Operating System Error Messages

The following messages should never be seen as they indicate an internal fault: @ F, REL S, REL M, REL L, REL U, GET U, @ S, @ W, @ P. If one does appear (the unit may be under either local or remote control), the following procedure should be adherred to:

1. Power-off the 7071.

2. Power-on and press the initialise control.

3. If the fault persists, power-off and hold the initialise control depressed whilst powering-on.

4. If this also fails to clear the fault, contact Solartron giving details of the error message and the exact circumstances of its occurrence.

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